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OF THE

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VOLUME THE EIGHTEENTH.

PRACTICE WITH SCIENCE.

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1857.

THESE EXPERIMENTS, IT IS TRUE, ARE NOT EASY; STILL THEY ARE IN THE POWER OF EVERY THINKING HUSBANDMAN. HE WHO ACCOMPLISHES BUT ONE, OF HOWEVER LIMITED APPLICATION, AND TAKES CARE TO REPORT IT FAITHFULLY, ADVANCES THE SCIENCE, AND, CONSEQUENTLY, THE PRACTICE OF AGRICULTURE, AND ACQUIRES THEREBY A RIGHT TO THE GRATITUDE OF HIS FELLOWS, AND OF THOSE WHO COME AFTER. TO MAKE MANY SUCH IS BEYOND THE POWER OF MOST INDIVIDUALS, AND CANNOT BE EXPECTED. THE FIRST CARE OF ALL SOCIETIES FORMED FOR THE IMPROVEMENT OF OUR SCIENCE SHOULD BE TO PREPARE THE FORMS OF SUCH EXPERIMENTS, AND TO DISTRIBUTE THE EXECUTION OF THESE AMONG THEIR MEMBERS.

VON THAER, *Principles of Agriculture.*

London: Printed by WILLIAM CLOWES and SONS, Stamford Street, and Charing Cross.

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APPENDIX.

DIRECTIONS TO THE BINDER.

The Binder is desired to collect together all the Appendix matter, with Roman numeral folios, and place it at the *end* of each volume of the Journal, excepting Titles and Contents, and Statistics, &c., which are in all cases to be placed at the *beginning* of the Volume: the lettering at the back to include a statement of the *year* as well as the *volume*; the first volume belonging to 1839–40, the second to 1841, the third to 1842, the fourth to 1843, and so on.

In Reprints of the Journal all Appendix matter (and in one instance an Article in the body of the Journal), which at the time had become obsolete, were omitted; the Roman numeral folios, however (for convenience of reference), being reprinted without alteration in the Appendix matter retained.

*** In binding the Volume, omit the duplicate of the Prizes for Essays and Reports (c *, pp. xxxix to xlii) given in this Part.

STATISTICS

OF

THE WEATHER, PUBLIC HEALTH, PRICE OF PROVISIONS, &c., &c.,

FOR THE SIX MONTHS ENDING DECEMBER 31, 1857.

Extracted from the Quarterly Returns of the Registrar General.

ON

THE METEOROLOGY OF ENGLAND

DURING

THE QUARTER ENDING SEPTEMBER 30TH, 1857.

BY JAMES GLAISHER, ESQ., F.R.S.,

SEC. OF THE BRITISH METEOROLOGICAL SOCIETY.

TILL the 9th of July the air was cold, and from the 10th to the end of the quarter, with but few exceptions, it was warm, and at times hot. The mean temperature of the month was 64°·5, being 3° nearly in excess; chiefly due to high day temperature.

August was warm throughout, excepting the 7th, 8th, 9th, 13th, and 14th, when the daily temperature was slightly in defect. The mean temperature of the month was 65°·8, being 5° nearly in excess, and due to both warm days and nights, but rather more to the former than the latter. Since the year 1771, a date as far back as trustworthy records extend, there has been one instance only in which the mean monthly temperature exceeded that of this month, viz. in July, 1778, when it was 67°·0, therefore the month of August of the present year has been the hottest of any for eighty years. The temperature at a few places reached 90°, and was but little less at many places.

September was warm throughout, with the exception of the 2nd, 3rd, 4th, and 11th. The mean temperature of the month was 59¾°, and exceeded the average by 3°, and due to both warm days and nights, but to a greater extent to the latter than the former.

The mean temperature of the dew point was above its average in each month of the quarter, but in July and August to less amounts than the excesses of temperature, and consequently the air was less humid in those months than usual. In September, however, it exceeded the excess of temperature, and consequently this month was more humid than usual.

The fall of rain was deficient in July, of its average amount in August, and in excess in September.

The mean temperature of the air at Greenwich for the quarter ending August, constituting the three summer months, was 64°·0, being 3°·7 above the average of eighty-six years.

THE WEATHER DURING THE QUARTER ENDING SEPTEMBER 30, 1857.

1857. Months.	Temperature of Air. Mean.	Air. Diff. from average of 86 years.	Air. Diff. from average of 16 years.	Evaporation. Mean.	Evaporation. Diff. from average of 16 years.	Dew Point. Mean.	Dew Point. Diff. from average of 16 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 16 years.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 16 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour. Diff. from average of 16 years.
	°	°	°	°	°	°	°	°	°	in.	in.	grs.	gr.
July	64·5	+2·8	+3·2	59·1	+1·7	54·8	+1·0	23·5	+3·4	·431	+·016	4·8	−0·2
August ..	65·8	+4·5	+5·3	60·8	+3·4	56·9	+2·8	21·7	+2·6	·465	+·042	5·2	+0·5
September..	59·7	+3·0	+3·4	57·2	+3·5	55·2	+4·4	18·1	−0·5	·436	+·056	4·8	+0·6
Mean....	63·3	+3·5	+4·0	59·0	+2·9	55·6	+2·7	21·1	+1·8	·444	+·038	4·9	+0·3

1857. Months.	Degree of Humidity. Mean.	Degree of Humidity. Diff. from average of 16 years.	Reading of Barometer. Mean.	Reading of Barometer. Diff. from average of 16 years.	Weight of a Cubic Foot of Air. Mean.	Weight of a Cubic Foot of Air. Diff. from average of 16 years.	Rain. Amount.	Rain. Diff. from average of 40 years.	Daily Horizontal movement of the Air.	Reading of Thermometer on Grass. Number of Nights it was At or below 30°.	Between 30° and 40°.	Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	Miles.				°	°
July	71	−5	29·847	+·055	526	+1	1·1	−1·6	58	0	0	31	41·0	58·2
August ..	73	−5	29·836	+·041	525	−3	2·6	−0·1	102	0	2	28	38·0	59·0
September..	86	+5	29·786	−·055	530	−4	3·4	+1·3	51	0	3	28	36·1	54·5
Mean....	77	−2	29·806	+·014	527	−2	Sum 7·1	Sum −0·2	Mean 70	Sum 0	Sum 5	Sum 87	36·0	59·0

NOTE.—In reading this table it will be borne in mind that the sign (−) minus signifies below the average, and that the sign (+) signifies above the average.

ON

THE METEOROLOGY OF ENGLAND

DURING

THE QUARTER ENDING DECEMBER 31st, 1857.

By JAMES GLAISHER, Esq., F.R.S.,

SEC. OF THE BRITISH METEOROLOGICAL SOCIETY.

OCTOBER.—Till the 4th the air was warm; it was then cold until the 10th; it was then again warm till the end of the month. The mean temperature of this month was 53°, being $3\frac{1}{2}$° in excess.

November was warm until the 12th; on the 12th and 13th it was cold: it was then again warm until the 24th; from the 24th to the end it was cold. The mean temperature of the month was 45°·8, being 2°·2 in excess.

December was remarkably warm throughout. The mean temperature of the month was 45°·1, being 5° in excess of the average, and due to both warm days and nights. The mean temperature of this month has been but twice exceeded since 1771, a period of eighty-six years, viz. in the years 1806 and 1852.

The mean temperature of the dew point was above its average in each month of the quarter, and in October and November to greater amounts than the excesses of temperature, and consequently the air was more humid than usual in those months. In December, however, the excess was about the same value as that of the air.

The fall of rain was in excess in October: on the 22nd a very heavy fall took place over the counties of Hertford, Cambridge, Buckingham, Middlesex, Surrey, Kent, Norfolk, and Sussex; it fell to the depth of nearly 3 inches in several places. In November and December the fall of rain was deficient, and was somewhat deficient upon the quarter, and about $3\frac{1}{2}$ inches deficient upon the year.

The mean temperature of the air at Greenwich for the quarter ending November, constituting the three autumnal months, was 52°·8, being 3°·4 above the average of the preceding eighty-six years.

THE WEATHER DURING THE QUARTER ENDING DECEMBER 31ST, 1857.

The Mean Temperature of the Air at Greenwich for the Quarter ending May, constituting the three Spring Months, was 47·2°, being 0·8° above the average of 86 years.

1857. MONTHS.	Temperature of Air. Mean.	Air. Diff. from average of 86 years.	Air. Diff. from average of 16 years.	Evaporation. Mean.	Evaporation. Diff. from average of 16 years.	Dew Point. Mean.	Dew Point. Diff. from average of 16 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 16 years.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 16 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour in a Cubic Foot of Air. Diff. from average of 16 years.
	°	°	°	°	°	°	°	°	°	in.	in.	grs.	gr.
October ..	52·9	+3·6	+3·6	51·6	+3·7	50·3	−4·8	14·5	−0·1	·368	+·062	4·1	+0·6
November .	45·9	+3·4	+2·3	45·0	+2·9	44·1	+3·8	11·3	−0·1	·289	+·031	3·3	+0·4
December .	45·0	+6·1	+4·8	43·9	+5·2	42·4	+5·5	10·7	+1·2	·268	+·042	3·1	+0·5
Mean	47·9	+4·4	+3·6	46·8	+3·9	45·6	+4·7	12·2	+0·3	·308	+·045	3·5	+0·5

1857. MONTHS.	Degree of Humidity. Mean.	Degree of Humidity. Diff. from average of 16 years.	Reading of Barometer. Mean.	Reading of Barometer. Diff. from average of 16 years.	Weight of a Cubic Foot of Air. Mean.	Weight of a Cubic Foot of Air. Diff. from average of 16 years.	Rain. Amount.	Rain. Diff. from average of 40 years.	Daily Horizontal movement of the Air.	Reading of Thermometer on Grass. Number of Nights it was At or below 30°.	Number of Nights it was Between 30° and 40°.	Number of Nights it was Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	Miles.				°	°
October ..	92	+6	29·695	+·014	536	−3	4·2	+0·9	71	0	14	17	35·2	54·0
November .	94	+6	29·942	+·197	548	+1	1·3	−1·0	38	11	11	8	22·2	52·2
December .	90	+2	30·155	+·342	553	+1	0·5	−1·0	117	12	8	11	24·0	45·0
Mean....	92	+5	29·931	+·184	546	0	Sum 6·0	Sum −1·1	Mean 75	Sum 23	Sum 33	Sum 36	Lowest 22·2	Highest 54·0

NOTE.—In reading this table it will be borne in mind that the sign (−) minus signifies below the average, and that the sign (+) signifies above the average.

STATE OF THE PUBLIC HEALTH.

1st Quarter.—100,590 deaths were registered in the quarter ending September 30th; and the death rate was 2·064 per cent. The deaths in the summer quarter of the previous year were 91,330; and in the summer of 1855 the deaths were 87,646. The excess of deaths in the last summer quarter over this number was 12,944.

The annual rate of mortality per 1000 during the summer was 25 in the town districts and sub-districts where 8,247,017 people dwelt in 1851 upon 2,149,800 acres; and 17 in the other districts and sub-districts of England and Wales where 9,680,592 people dwelt on 35,175,115 acres. The Arts which have been invented in cities are now required to render their natural homes healthy. As a preliminary to all other steps the people must be supplied with pure water. The town manures must be restored to the disinfecting fields every day, and no longer be suffered either to remain under human dwellings, or to pollute the streets and streams around them.

If the mortality in the towns had been at the same rate as the mortality in the other districts, the deaths, instead of amounting to 55,733, would have only amounted to 38,080.

Thus in 92 days 17,653 persons perished untimely in England.

2nd Quarter.—110,697 deaths were registered in the last quarter of the year 1857. This number exceeds by 14,176 the deaths in the corresponding quarter of 1856, and by 11,646 the average of the ten previous corresponding quarters. The mortality in the quarter was at the rate of 2·265 per cent. per annum, the average of the season being 2·167. The increase was equivalent to *one* on every 22 deaths. The increase of the mortality was greatest in the town districts or sub-districts, where 60,186 persons died, that is, 6923 above the average (53,263); while the deaths in the country districts amounted to 50,511 or 4724 above the average, 45,787. After correcting for increase of population, on the assumption that the population in town and country increased at the same rates as in the ten years 1841-51, the mortality in the towns appears to be at the rate of 2·704 per cent., in the country at the rate of 1·926 per cent. per annum. The excess over the average of the season was ·1-2 in the towns, ·050 in the country; it was, therefore, more than three times as great in the town as it was in the country districts.

The deaths in the year 1857 amounted to 420,019; and if the population of England and Wales is correctly estimated at 19,304,000 in the middle of that year, the rate of mortality was 2·176 per cent., or somewhat less than 22 to 1000 of the population. The average of the ten preceding years is 2·276 per cent.; consequently the mortality on the year 1857 was below the average.

THE PRICE OF PROVISIONS.

1*st Quarter*.—The average price of wheat was 76*s*. 1*d*. and 72*s*. 3*d*. in the two periods of thirteen weeks ending September 1855, and September 1856; it fell to 59*s*. 11*d*. in the thirteen weeks ending September 1857. Wheat is consequently 17 per cent. cheaper than it was last year. The price of beef by the carcase in the Leadenhall and Newgate markets has fallen in the three summers from $5\frac{7}{8}d.$ to $5\frac{3}{8}d.$ per pound; that is, $8\frac{1}{2}$ per cent. The price of mutton by the carcase has fallen from 6*d*. to $5\frac{3}{4}d.$ a pound, or 4 per cent., in the same seasons. The price of potatoes has unfortunately risen from 74*s*. to 78*s*. and to 105*s*. a ton, in the three seasons; it was 42 per cent. higher in the thirteen weeks ending September 1857 than the prices of the same season in 1855. The scarcity of potatoes is likely to produce scurvy in the country, as people are not generally aware that potatoes are an anti-scorbutic, which can only be replaced by fruit and vegetables. The abundant crop of apples will supply to a certain extent the vegetable acids which experience has shown that the human frame requires to maintain its elements in equilibrium.

2*nd Quarter*.—The price of wheat was 52*s*. a quarter, while in the corresponding three months of 1855 and 1856 it was 79*s*. 4*d*. and 63*s*. 4*d*. The reduction was 34 and 18 per cent. respectively on the prices of the two previous years. The price of beef by the carcase at the Leadenhall and Newgate markets was $5\frac{3}{8}d.$ per pound, while it was in the same seasons of 1855 and 1856 respectively $5\frac{6}{8}d.$, and $5\frac{2}{8}d.$ a pound. Mutton was in the autumns of the three years (1855, 1856, and 1857) $5\frac{6}{8}d.$ a pound. The potato crop failed, and the average price of York Regents at the waterside market, Southwark, was 140*s*. a ton, or 16 lbs. for a shilling. In the preceding autumns of 1855 and 1856 the price of potatoes was 95*s*. and 100*s*. a ton. The price of potatoes was 40 per cent. higher than it was in the three autumn months of 1856. This high price necessarily limits the consumption of potatoes among the poorer classes of artizans in the towns; and the family of the labourer, whose crop has failed in the country, must suffer still more severely, as he has not the means of purchasing other commodities. The want of potatoes often induces scurvy, but no direct evidence of that disease is yet mentioned by the registrars. It is, however, not seldom the marked cause of other maladies.

THE PRICE OF PROVISIONS.

[illegible] of Wheat, Meat, and Potatoes; also the AVERAGE [illegible] and imported weekly, in each of the Nine Quarters [illegible] 31st, 1857.

[illegible]	[illegible]	[illegible]	[illegible] Wheat Sold in 290 Cities and Towns in England and Wales, making Returns.*	Wheat and Wheat Flour entered for Home Consumption at Chief Ports of Great Britain.*	Average Prices of Meat per lb. at Leadenhall and Newgate Markets (by the Carcase). Beef.	Mutton.	Potatoes (York Regents) per Ton at Waterside Market, Southwark.
			Average number of Quarters weekly.				
1855							
Dec. 31	[illegible]	[illegible]	126,093	42,358	4¾d.—6¾d. Mean 5¾d.	4¾d.—6¾d. Mean 5¾d.	90s.—100s. Mean 95s.
1856							
Mar. 31	[illegible]	[illegible]	92,152	48,118	4¼d.—6½d. Mean 5¼d.	4¼d.—6½d. Mean 5⅜d.	78s.—93s. Mean 86s.
June 30	[illegible]	[illegible]	104,952	63,093	4¼d.—6¼d. Mean 5¼d.	5d.—6¾d. Mean 5⅞d.	70s.—90s. Mean 80s.
Sept. 30	[illegible]	[illegible]	[illegible]	117,877	4½d.—6½d. Mean 5½d.	5d.—7d. Mean 6d.	75s.—80s. Mean 78s.
Dec. 31	[illegible]	[illegible]	112,979	103,328	3¾d.—6¾d. Mean 5¼d.	4¾d.—6¾d. Mean 5¾d.	90s.—110s. Mean 100s.
1857							
Mar. 31	[illegible]	[illegible]	102,433	51,310	4½d.—6¾d. Mean 5⅝d.	5¼d.—7¼d. Mean 6¼d.	100s.—120s. Mean 110s.
June 30	[illegible]	[illegible]	[illegible]	42,178	4¼d.—6½d. Mean 5⅜d.	4¾d.—6¾d. Mean 5¾d.	105s.—150s. Mean 127s. 6d.
Sept. 30	[illegible]	[illegible]	92,156	55,384	4¼d.—6½d. Mean 5⅜d.	4½d.—7d. Mean 5¾d.	95s.—115s. Mean 105s.
Dec. 31	[illegible]	[illegible]	[illegible]	95,587	4¾d.—6½d. Mean 5⅝d.	4½d.—7d. Mean 5¾d.	130s.—150s. Mean 140s.
Col.	1	2	3	4	5	6	7

* NOTE.—The total number of quarters of wheat sold in England and Wales for the 13 weeks [illegible] December 31st, 1855, 1,649,610; for the 13 weeks ending March 31st, 1856, 1,197,970; [illegible] the 13 weeks ending June 30th, 1856, 1,364,370; for the 13 weeks ending September 30th, 1856, 1,216,704; for the 13 weeks ending December 31st, 1856, 1,467,816; for the 13 weeks ending March 31st, 1857, 1,331,623; for the 13 weeks ending June 30th, 1857, 1,402,051; for the 13 weeks ending September 30th, 1857, 1,198,029; and for the 13 weeks ending December 31st, 1857, [illegible]. The total number of quarters entered for Home Consumption was respectively, [illegible]; 624,283; 820,206; 1,531,489; 1,446,588 (14 weeks); 667,027; [illegible]; [illegible]; and 1,242,628.

STATISTICS

OF

THE WEATHER, PUBLIC HEALTH, PRICE OF PROVISIONS, &c., &c.,

FOR THE SIX MONTHS ENDING JUNE 30, 1857.

Extracted from the Quarterly Returns of the Registrar General.

THE DIAGRAM SHOWING THE WEEKLY AVERAGE PRICE OF WHEAT IS SUPPLIED BY MR. HENRY S. BRIGHT OF HULL.—ED.

ON

THE METEOROLOGY OF ENGLAND

DURING

THE QUARTER ENDING MARCH 31ST, 1857.

BY JAMES GLAISHER, ESQ., F.R.S.,

SEC. OF THE BRITISH METEOROLOGICAL SOCIETY.

THE temperature of the air differed little from its average value during the quarter.

The periods and average daily amounts of excess were January 1st to 4th, $7\frac{3}{4}°$; January 9th to 20th, $3\frac{1}{4}°$; February 6th to 24th, $3\frac{1}{2}°$; February 27th to March 7th, 3°; March 14th to 20th, 5°; and March 28th to the end of the month, $4\frac{1}{2}°$.

The periods and average daily amounts of defect were January 5th to 8th, $3\frac{1}{2}°$; January 21st to February 5th, $6\frac{1}{4}°$; February 25th and 26th, $3\frac{1}{2}°$; March 8th to the 13th, $4\frac{3}{4}°$; and March 21st to the 27th, 4°.

The pressure of the atmosphere was in excess in February, and in defect in the other two months of the quarter. It was from 0·2 inch to 0·3 inch greater in February than in the preceding month, and from 0·1 inch to 0·2 inch less in March than in February.

The degree of humidity was a little in excess upon the quarter.

The daily ranges of temperature were in excess in January and February, particularly in the latter month, and of their average values in March.

Rain was slightly in excess in January, and in defect in February and March, particularly in the former month, so small a quantity not having fallen in any February since the year 1821, and was in defect to the amount of $1\frac{1}{2}$ inches upon the quarter.

The quarter was remarkable for the storms of snow and hail experienced in March, the hail-balls being large in size and pyramidal in shape.

Also for the very large barometer ranges; each month exceeding 1 inch; and for March in the South of England the range was about $1\frac{1}{4}$ inch; increasing up the country, till at the farther extremity it was nearly 2 inches.

The *mean temperature* of the air at Greenwich for the quarter ending February, constituting the three winter months, was 38·7°, being 1·0° above the average of 86 years.

The Weather during the Quarter ending March 31, 1857.

1857. Months.	Temperature of Air. Mean.	Air. Diff. from average of 86 years.	Air. Diff. from average of 16 years.	Evaporation. Mean.	Evaporation. Diff. from average of 16 years.	Dew Point. Mean.	Dew Point. Diff. from average of 16 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 16 years.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 16 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour. Diff. from average of 16 years.
	°	°	°	°	°	°	°	°	°	in.	in.	grs.	gr.
January ..	36·6	+0·6	−1·5	35·7	−1·5	34·6	−0·9	9·7	+0·3	·200	−·005	2·3	−0·1
February ..	39·2	+0·9	+0·7	37·6	+0·6	35·5	+0·9	14·7	+3·9	·208	+·005	2·4	+0·1
March	41·8	+0·9	+0·2	39·6	+0·4	36·8	+0·5	14·6	0·0	·218	+·002	2·5	−0·2
Mean....	39·2	+0·8	−0·2	37·6	−0·2	35·6	+0·2	13·0	+1·4	·209	+·001	2·4	−0·1

1857. Months.	Degree of Humidity. Mean.	Degree of Humidity. Diff. from average of 16 years.	Reading of Barometer. Mean.	Reading of Barometer. Diff. from average of 16 years.	Weight of a Cubic Foot of Air. Mean.	Weight of a Cubic Foot of Air. Diff. from average of 16 years.	Rain. Amount.	Rain. Diff. from average of 40 years.	Daily Horizontal movement of the Air.	Reading of Thermometer on Grass. Number of Nights it was At or below 30°.	Between 30° and 40°.	Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	Miles.				°	°
January ..	92	+3	29·634	−·085	553	0	2·6	+0·8	104	20	10	1	8·9	41·0
February ..	87	+1	29·952	+·185	556	+3	0·2	−1·5	51	25	3	0	10·7	32·7
March	84	+2	29·720	−·086	549	−2	0·8	−0·8	88	22	7	2	15·5	42·2
Mean....	88	+2	29·769	+·005	553	0	3·6	Sum −1·5	Sum 243	Sum 67	Sum 20	Sum 3	8·9	42·2

Note.—In reading this table it will be borne in mind that the sign (−) minus signifies below the average, and that the sign (+) signifies above the average.

ON

THE METEOROLOGY OF ENGLAND

DURING

THE QUARTER ENDING JUNE 30TH, 1857.

BY JAMES GLAISHER, ESQ., F.R.S.,

SEC. OF THE BRITISH METEOROLOGICAL SOCIETY.

APRIL, till the 10th day, and from the 17th to the 21st, was hot, the day temperatures within these periods being 5½° in excess; from the 11th to the 16th, and from the 24th it was cold, snow falling on every day, and the daily defect of temperature was 6°; the temperature for the month was about 1° below that of the average of the preceding 16 years. May was cold till the 10th, the average daily defect of temperature was 6°; from the 11th it was warm, rising in the middle of the month to summer temperature, the maximum in the shade in many places exceeding 80°; there was a deficiency of rain; the temperature for the month was somewhat in excess. June was warm till the 8th; it was cold from the 9th to the 18th, and hot from the 19th; on the 28th the temperature near the sea rose to 75°; at places between the latitudes of 51° and 52° it exceeding 91° and in some places 92°; in London it was 88°; and at all other places it was somewhat below 90°. This day was the hottest we have experienced since 1846, July 6th; and it was also remarkable for the small amount of water in the air in the invisible shape of vapour, the temperature of the dew-point being fully 35° below that of the air, at times, during the day. The temperature for the month was 3° in excess above the average. In April the temperature by day was about 1¼° below that of the average; in May was about 3° above, and in June was about 5¼° above their respective average temperatures; during the whole quarter the temperature by night has been that of the average. The excess of temperature upon the quarter has therefore been wholly attributable to higher day temperature than usual from May 11th to June 8th, and from June 19th; and so also the greater daily ranges of temperature are owing to the same cause.

THE WEATHER DURING THE QUARTER ENDING JUNE 30, 1857.

The Mean Temperature of the Air at Greenwich for the Quarter ending May, constituting the three Spring Months, was 47·2°, being 0·8° above the average of 86 years.

1857. Months.	Temperature of Air. Mean.	Air. Diff. from average of 86 years.	Air. Diff. from average of 16 years.	Evaporation. Mean.	Evaporation. Diff. from average of 16 years.	Dew Point. Mean.	Dew Point. Diff. from average of 16 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 16 years.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 16 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour. Diff. from average of 16 years.
	°	°	°	°	°	°	°	°	°	in.	in.	grs.	gr.
April	45·7	0·0	−0·9	43·1	−0·4	40·0	−0·1	17·0	−1·2	·247	−·003	2·8	−0·1
May......	54·0	+1·5	+1·1	50·0	+0·9	45·8	+0·3	23·1	+3·1	·308	−·008	3·5	−0·1
June	61·8	+3·8	+3·2	56·8	+2·3	52·0	+1·5	24·4	+3·6	·388	+·011	4·3	+0·3
Mean	53·8	+1·8	+1·1	50·0	+0·9	45·9	+0·6	21·5	+1·8	·314	·000	3·5	0·0

1857. Months.	Degree of Humidity. Mean.	Degree of Humidity. Diff. from average of 16 years.	Reading of Barometer. Mean.	Reading of Barometer. Diff. from average of 16 years.	Weight of a Cubic Foot of Air. Mean.	Weight of a Cubic Foot of Air. Diff. from average of 16 years.	Rain. Amount.	Rain. Diff. from average of 40 years.	Daily Horizontal movement of the Air.	Reading of Thermometer on Grass. Number of Nights it was At or below 32°.	Between 32° and 40°.	Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	Miles.				°	°
April	82	+3	29·632	−·111	543	−1	1·4	−0·9	91	13	14	3	15·9	47·0
May......	74	−3	29·786	+·030	537	0	0·6	−2·9	55	10	12	9	18·1	50·7
June	72	−2	29·858	+·063	530	−1	2·7	+1·1	87	3	11	16	29·5	57·8
Mean	76	−1	29·759	−·006	537	−1	Sum 4·7	Sum −1·7	78	Sum 26	Sum 37	Sum 28	18·1	57·8

NOTE.—In reading this table it will be borne in mind that the sign (−) minus signifies below the average, and that the sign (+) signifies above the average.

STATE OF THE PUBLIC HEALTH.

1st Quarter.—108,527 deaths were registered in the winter quarter of this year, and the annual rate of mortality was nearly 23 in 1000, against the average of the season 25. The winters of 1846, 1850, and 1856 alone, within the registration range of observation commencing in 1838, show a lower rate of mortality; and the winter of 1846, exceedingly mild, was followed by a hot summer, which gave birth to a severe epidemic of diarrhœa and summer cholera. The temperature of the last winter quarter differed little from the average, and will not account for the low rate of mortality, which may be partly referred to improvements in the sanatory condition of the people. In the country, and still more in the towns, there is, however, great room for further improvement; for the mortality in the villages and small towns was at the rate of nearly *twenty*, in the large town districts, *twenty-six* in 1000.

2nd Quarter.—100,205 deaths were registered in the quarter ending June 30, and this implied an annual mortality at the rate of 2·086 per cent. The mortality in the districts containing the principal towns was at the annual rate of 2·323, that is ·125 less than 2·448, the average of the preceding *ten* spring quarters. In the remaining district, comprising chiefly small towns and country parishes, the reduction in the annual rate of mortality was ·210; it was 1·873, while the average rate of the season was 2·083.

THE PRICE OF PROVISIONS.

1st Quarter.—Wheat, which was 72*s.* 4*d.* a quarter in the winter of last year, has fallen to 56*s.* 10*d.* in the winter of the present year. But potatoes have risen from 86*s.* to 110*s.* a ton at the water-side market, Southwark; beef from 5¼*d.* to 5¾*d.*; and mutton, from 5⅝*d.* to 6⅝*d.* a pound, by the carcase, in the Leadenhall and Newgate markets. Thus the price of wheat fell 21 per cent.; while the price of potatoes in London rose 28, of beef 10, and of mutton nearly 16 per cent.

2nd Quarter.—The average price of wheat, like that of consols, has been nearly the same as it was in the three first months of the year; it was 56*s.* 9*d.* in the thirteen weeks of April, May, and June, 1857: and consequently wheat is cheaper by 23 per cent. and 17 per cent. than it was in the corresponding seasons of 1855 and 1856. In the London markets beef has risen 7 per cent., while mutton has slightly fallen since last year. The high price of potatoes is the most unfavourable circumstance in the Table. The price of this important esculent has been 60 per cent. higher in London than it was in the spring quarter of 1856. The abundant crop of fruit will, to a certain extent, supply its place as an anti-scorbutic; and we may hope that this year's crop of potatoes will be more abundant.

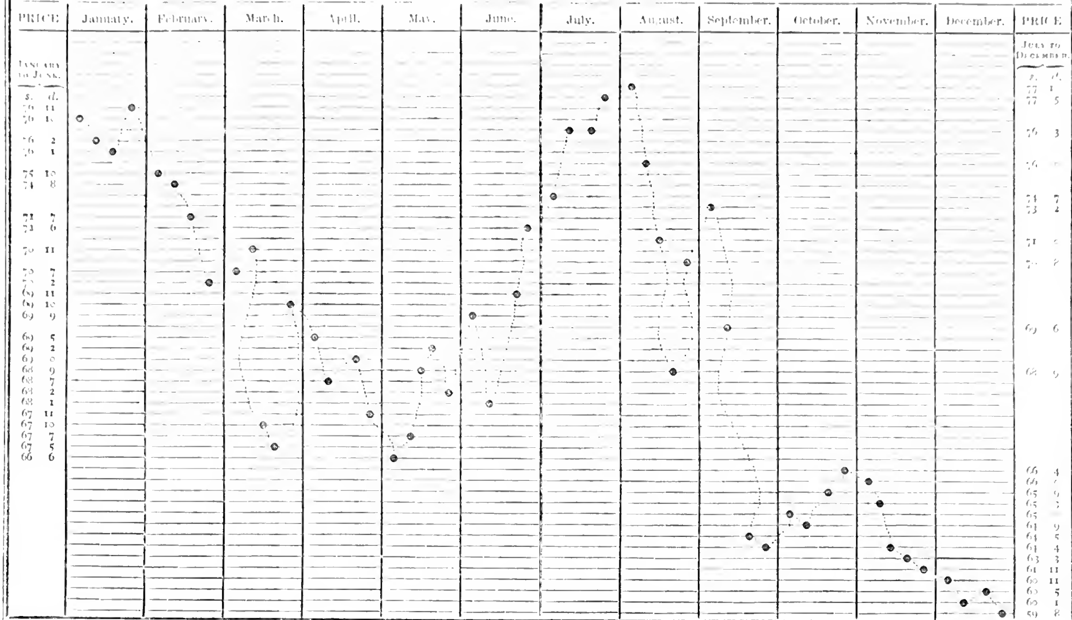
THE PRICE OF PROVISIONS.

The AVERAGE PRICES of Consols, of Wheat, Meat, and Potatoes; also the AVERAGE QUANTITY of Wheat sold and imported weekly, in each of the Nine Quarters ending June 30th, 1857.

Quarters ending	Average Price of Consols (for Money).	Average Price of Wheat per Quarter in England and Wales.	Wheat sold in the 290 Cities and Towns in England and Wales making Returns.*	Wheat and Wheat Flour entered for Home Consumption at Chief Ports of Great Britain.*	Average Prices of Meat per lb. at Leadenhall and Newgate Markets (by the Carcase).		Average Prices of Potatoes (York Regents) per Ton at Waterside Market, Southwark.
			Average number of Quarters weekly.		Beef.	Mutton.	
1855	£.	s. d.					
June 30	$90\frac{6}{8}$	73 4	94,791	57,068	$4\frac{1}{2}d.$—$6\frac{1}{2}d.$ Mean $5\frac{1}{2}d.$	$4\frac{3}{4}d.$—$6\frac{3}{4}d.$ Mean $5\frac{3}{4}d.$	110s.—130s. Mean 120s.
Sept. 30	$90\frac{6}{8}$	76 1	94,545	51,511	5d.—$6\frac{3}{4}d.$ Mean $5\frac{7}{8}d.$	5d.—7d. Mean 6d.	69s.—79s. Mean 74s.
Dec. 31	$88\frac{1}{4}$	79 4	126,893	42,358	$4\frac{3}{4}d.$—$6\frac{3}{4}d.$ Mean $5\frac{3}{4}d.$	$4\frac{3}{4}d.$—$6\frac{3}{4}d.$ Mean $5\frac{3}{4}d.$	90s.—100s. Mean 95s.
1856							
Mar. 31	$90\frac{6}{8}$	72 4	92,152	48,018	$4\frac{1}{4}d.$—$6\frac{1}{4}d.$ Mean $5\frac{1}{4}d.$	$4\frac{1}{4}d.$—$6\frac{1}{2}d.$ Mean $5\frac{3}{8}d.$	78s.—93s. Mean 86s.
June 30	$95\frac{3}{8}$	68 8	104,952	63,093	$4\frac{1}{4}d.$—$6\frac{1}{4}d.$ Mean $5\frac{1}{4}d.$	5d.—$6\frac{3}{4}d.$ Mean $5\frac{7}{8}d.$	70s.—90s. Mean 80s.
Sept. 30	95	72 3	78,208	117,807	$4\frac{1}{2}d.$—$6\frac{1}{2}d.$ Mean $5\frac{1}{2}d.$	5d.—7d. Mean 6d.	75s.—80s. Mean 78s.
Dec. 31	$92\frac{6}{8}$	63 4	112,909	103,328	$3\frac{3}{4}d.$—$6\frac{3}{4}d.$ Mean $5\frac{1}{4}d.$	$4\frac{3}{4}d.$—$6\frac{3}{4}d.$ Mean $5\frac{3}{4}d.$	90s.—110s. Mean 100s.
1857							
Mar. 31	$93\frac{4}{8}$	56 10	102,433	51,310	$4\frac{1}{2}d.$—$6\frac{3}{4}d.$ Mean $5\frac{3}{4}d.$	$5\frac{1}{4}d.$—$7\frac{1}{4}d.$ Mean $6\frac{1}{4}d.$	100s.—120s. Mean 110s.
June 30	$93\frac{3}{8}$	56 9	107,850	42,178	$4\frac{1}{4}d.$—$6\frac{1}{2}d.$ Mean $5\frac{5}{8}d.$	$4\frac{3}{4}d.$—$6\frac{3}{4}d.$ Mean $5\frac{3}{4}d.$	105s.—150s. Mean 127s.6d.
Col.	1	2	3	4	5	6	7

* NOTE.—The total number of quarters of wheat sold in England and Wales for the 13 weeks ending June 30th, 1855, 1,232,284; for the 13 weeks ending September 30th, 1855, 1,229,082; for the 13 weeks ending December 31st, 1855, 1,649,610; for the 13 weeks ending March 31st, 1856, 1,197,970; for the 13 weeks ending June 30th, 1856, 1,364,370; for the 13 weeks ending September 30th, 1856, 1,016,704; for the 13 weeks ending December 31st, 1856, 1,467,816; for the 13 weeks ending March 31st, 1857, 1,331,623; and for the 13 weeks ending June 30th, 1857, 1,402,051. The total number of quarters entered for Home Consumption was respectively, 741,890; 669,639; 550,652; 624,233; 820,206; 1,531,489; 1,446,588 (14 weeks); 667,027; and 548,315.

1856.—WEEKLY AVERAGE PRICE OF **WHEAT** FROM GOVERNMENT RETURNS.



	Wheat.	Barley.	Oats.	Beans.	Peas.	Maize.	Flour and Meal.
Average of Year	69/2	41/1	25/2	43/11	41/8	..	..
	qrs.	*qrs.*	*qrs.*	*qrs.*	*qrs.*	*qrs.*	*cwts. qrs. lbs.*

JOURNAL

OF THE

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

I.—*The Farming of Bedfordshire.* By William Bennett, of Cambridge.

Prize Essay.

Having resided in Bedfordshire, my native county, upwards of half a century, and been engaged for many years in the practical operations of farming, even to the handling of the plough and the sickle, I trust that the fact of my being so intimately acquainted and identified with the agriculture of this county, will justify this attempt to write on the subject, and countervail any defects of style.

Although Bedfordshire must be classed as a second or even third-rate county in territorial extent, population, and the natural fertility of much of its soil, yet in the progress of its agriculture, in the improvement of its stock, and, it may be added, in the social order, public spirit, and intelligence of its yeomen, it occupies an honourable and prominent position among the counties of England.

That the farming of Bedfordshire was in a deplorable state at the latter end of the last century may be proved by a reference to the Report to the Board of Agriculture, made by Mr. Stone of Gray's Inn, in 1794. Much of the arable land of the county was then (60 years ago) in the open or common field state, and subjected, without reference to the different kinds of soil, to very much the same management, though perhaps mismanagement would be an apter word. Mr. Stone observes—"Land of a clayey nature, whether found in a state of arable or pasture, has been evidently ridged up for a series of years upon a *false principle of drainage*,* till the tops of the ridges, for six or eight feet across, are the only profitable parts of the soil; the furrows and the land adjacent form so many pools, ditches, and reservoirs of water."

Underdraining seems at that time to have been out of the question, for the writer goes on to say:—"It is the common

* See Note, p. 5.

practice to make open water or head-furrows on this description of land only where crops of corn are sown or in the first stages of their growth. Attempts of this kind are seldom made at other seasons, from which neglect the finest particles of manure, mucilage, or food of plants are damaged or washed away, and the cells of the plants are rotted and their tubes wasted or destroyed." "The mischievous effects of this wretched system of farming," the writer adds, "are not confined to the growth of corn, but the destruction of cattle and sheep depastured thereon is but too frequently produced—not merely by the rot of a single farmer's flock, but occasionally of nearly the entire sheep of a village and neighbourhood."

We shall have occasion to make further reference to this Report, but these facts may suffice to show some of the difficulties with which our present farmers have had to contend.

The county of Bedford is computed to be about 35 miles from north to south, and a little upwards of 22 miles from east to west, containing an area of about 480 square miles, or, according to Mr. Stone's estimate, about 307,200 acres: if we take Mr. Beak on income tax, 293,059 acres; or the Parliamentary Gazetteer, 296,320 acres. We adopt this last computation, being the medium and most modern. It is divided into nine separate hundreds or polling-places, 124 parishes, and 10 market-towns, viz. Bedford, Ampthill, Woburn, Leighton-Buzzard, Dunstable, Luton, Toddington, Shefford, Biggleswade, and Potton.

Since the construction of the railroads, Bedford and Leighton-Buzzard have become the leading corn-markets.

The soil of the county varies much; but, for our present purpose, it is scarcely necessary to divide it into more than the three following principal classes or descriptions, although there are two or three sub-varieties which will require cursory notice.

I. *The Tenacious Clay Soils*, lying on a bed of blue marl, brick earth, or gault.

II. *The Gravelly and Sandy Loams*, with a subsoil of gravel, greensand, or sandstone.

III. *The Thin, Loose, Mixed Soils*, upon the oolite or chalk formation.

First. The *Clay-land* forms nearly the whole northern division of the county below Bedford. From the southern base of Clapham Hill to Shelton, the extreme northern boundary; and in the opposite direction from Beggary to Cold Harbour—ominous terms!—comprising nearly one-third of the county, you have clay-soil, excepting that small intersection composed of a strip of low land and the meadows adjoining the Ouse. Of this intersection the subsoil is chiefly gravel, but in several parishes

on the north-west will be found some narrow beds of limestone, dividing the gravel from the great body of clay; in that part of the county the soil is generally good cropping-land.

There are but three rivers in this county worthy of notice—*the Ouse, the Ivel,* and *the Lea.* The former, by far the largest, enters the county on the north-west, at Turvey, bearing with it the tributary waters of Buckinghamshire, and describes a course so singularly winding that, before it reaches Bedford, a distance in a direct line of only 8 miles, it has performed a circuit of about 26 miles; thence it pursues its deviating path to St. Neot's, on reaching which it has left the county. The lands in the district thus described present many differences in point of quality and cultivation, but there is throughout an adhesive clay-soil. Again, starting from Stevington, and passing through Stagsden, Kempston, Wooten-bone-end, and Cranfield, you make the western boundary. Then, on the east, commence at the back settlements of Little Barford, Tempsford-Marsh, Everton Downs, until you approach the Hazels; thence you may reach, *per saltum*, Cockayne-Hatley, Wrestingworth, and Dunton, and so complete the eastern boundary. In all these districts there are still the same unyielding, tenacious clays.

Further, if you scale the hills to Brogborough-High-House; glance across the lands which intervene to Battlesden, Eggington, Stanbridge, and Billington; then more southerly, to the back of Silsoe, Gravenhurst, Meppershall, Shillington, Higham, and Barton; and now commence a tour, in an opposite direction, over the Lidlington Flat to Morston, in which vicinity are some of the best grass-lands in the county; thence to Wootton, Houghton Conquest, Wilshamstead, *viâ* Moxhill Farm and Cople-Hoo, you will have seen or traversed, not all, but by far the greater part, of the clay-lands of Bedfordshire.

This last district can boast of the best class of strong land, and will yield, by good farming, and in favourable seasons, the most splendid crops. Nothing is more certain than that even these clay-lands, when in the hands of persevering and enterprising farmers, can be made exceedingly productive. Indeed, the obstacles overcome and the improvements effected by men of this stamp during the last 30 years are worthy of all praise. The land has been drained; many of the old crooked ridges have become straight; wide and irregular fences, as needless and wasteful as they were ugly, have been removed; straight white-thorn fences have been planted, and are kept about four feet high; while many of the roads, which were formerly impassable, are now good and well kept.

The improved state of the clay-lands in this county must, to a great extent, be attributed to successful underdraining. This

is a subject far too important to be passed over slightly. It has now become patent to all who are familiar with the principles and practice of agriculture, that to drain properly is the secret of all good and profitable farming where the soil is wet and tenacious. At the commencement of the present century no county in England, probably, stood in need of underdraining more than Bedfordshire, and within that period few counties have made greater progress in this department of good husbandry. The improvement effected by the process is permanent, and therefore, it is asserted, the expense ought to be borne by the landlord, and not by the tenant, especially where the farmer is a tenant at will.

But it is not our province to discuss this question. His Grace the Duke of Bedford will and does drain, where draining is required, and the tenant is charged 6 per cent. on the outlay and required to do the cartage. Thus the interest paid will in a course of years reimburse the landlord for the original outlay, while the improvement is by no means exhausted. The land is improved and both parties benefited. On the other hand, tenants who have the means, generally prefer doing the workmanship and cartage at their own expense, the landlord supplying them with tiles, because, by this course, they avoid additional rent.

But, there is doubtless much to be said in opposition to this method. All tenants are not equally judicious in the use of the tiles nor equally faithful in properly executing the work, consequently it is a source of annoyance to landlords, where expense has been incurred, without the improvement expected being realised. The farmers, moreover, have not been agreed as to the best kind of materials, the depth at which they should be deposited, or the direction of the drains; these have long been debatable points. Strong prejudice has existed against deep-draining and the use of tiles, especially on the more stiff and retentive clays of the county: even yet it is not entirely extinct. Meanwhile, notwithstanding the power of prejudice, and the clash of discordant opinions, the land, in one form or another, has been drained; and some of it, where the more fragile materials of bushes and straw have been used in shallow drains, has been twice, and in some cases three times drained within my own memory.

Pipe-tiles have at length established their reputation, and the advantages of deeper draining are almost universally acknowledged. In successfully grappling, however, with this subject, and in reducing the theory to practice, there have been, and still are, considerable difficulties to overcome. Fully nine-tenths of the clay-soils of the county have been from time immemorial ploughed into crooked and high back "lands" of irregular width and height;

so that the subsoil, a little below where the plough penetrates, has become (through the absence of atmospheric influence for so long a time) intractable pretty much in the form of these "lands."

Any sudden attempt to produce an entirely even surface could scarcely fail to be succeeded by injury to the crops for some years subsequent. It is not surprising, therefore, that farmers have not agreed upon any general or uniform mode of underdraining these lands. Some prefer taking the drain down the old furrow, which is always (though irregularly) lower than any other part of the land. But others, because of the great inequality in the size of the lands, prefer to place their drains at regular intervals, irrespective altogether of the old lands and about 4 feet deep. Two or three of the principal estates of the county are drained, mainly, I believe, in this method; and wherever the subsoil is sufficiently porous the end is answered and a tolerably perfect drainage effected. On the other hand, where these drains pass, as they often do, through impervious beds of gault, they fail, as might be expected, to draw the water from the parts of these old lands that lay lower before drainage, and sometimes serious damage ensues. Therefore it is the more popular practice among many farmers to drain down the old furrows at a depth sufficient to save the pipes from all chance of damage, thereby adopting as their principle the consideration that the surface-water percolates through cultivated soil to the lowest point more freely than through that which is more impervious.* I contend, therefore, that on all such lands the drain, when it can be accomplished, should be found in those places where the surface is lowest. These observations are intended to apply particularly to the very tenacious soils of the county

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* In other words, their idea of drainage is, according to the author, confined to the production of a dry face upon ridges weeping their surface-wet *sideways through the cultivated soil into the adjacent furrows* (illustrated in the soaking of rain down the sides of an umbrella, whose top will be dry while the sides are still saturated). It hardly needed any new discovery that water percolates more freely through a soil than through a clay subsoil, to get back to that long-exploded theory of drainage, which is costing *re-drainage* on so many estates.

It is quite true, as the author states, that old ridges must be reduced very gradually, with a care and judgment that every experienced farmer will know how to apply. But this, which is *one* truth, does not invalidate *another* truth—that the object of agricultural drainage is to relieve the soil by *draining the cold and indurated subsoil;* effecting by degrees the direct *under-absorption* of water to the *drains*, instead of its *lateral soakage* to the *furrows*.

Experience has shown that lateral soakage, inevitably implying as it does an unequal distribution of moisture on the surface, is an evil gradually superseded by the deep drain, a process involving time on land of this well-known description in the midland counties. But it is precisely for this reason the more important that the *true end and aim* of drainage should be steadily and patiently kept in view by those who have high-backed ridges to contend with; indicating as they do the greatest local *need* of drainage, and its worst *example* to the eye. —Ed.

where the system of thus ridging up the lands has prevailed for ages.

On an even surface, draining, at regular intervals, is doubtless the correct principle; but even with such a surface, on very retentive soils, the drains ought to be at intervals of not more than 22 feet, that is, three drains in the chain. On thoroughly open porous soils, with deep drains, it is difficult to say to what distance water may be drawn; there is now a striking illustration, just on the border of the county, where the Grand Junction Canal Company, to obtain water for their reservoir, have recently dug a drain that has laid dry the wells of entire parishes.

But, to return to the ridged-up lands. When the draining is completed our more skilful farmers lower them, only so far as the soil will permit, and then strike out the new lands, often obliquely over the drains, taking care to secure the best fall.

Many of the best farmers adopt at present the narrow twelve-furrow ridges; a plan which enables them to drill and harrow with the horses in the furrow. Thus they avoid poaching the land when wet. Among others, Mr. Pain and his sons at Felmersham have long adopted this system, and the county cannot boast of better farmers. There are others, however, who, after reducing judiciously the old lands, plough straight, but not in narrow ridges.

Here and there, perhaps, you may encounter a farmer whose reverence for the old serpentine system of ploughing is so profound, that, for the life of him, he will not go in any other direction. There are farms in the county where modern cultivation is scarcely known. A drive from Bedford to Kimbolton still exhibits too many illustrations. Indeed there are everywhere some men who are so wedded to the usages of a dead past as to regard with suspicion any innovation on the old routine, even though the facts of science and the experience of practical men declare the change to be an absolute improvement. To the credit of Bedfordshire, however, be it said, that cases of this description are exceedingly rare; and the few remaining venerators of antiquity are gradually adopting those methods of farming which modern times have proved to be superior to those of a by-gone age.

Tillage and Cropping.—Different modes of farming this strong land are still adopted. The most prevalent is the four-course system, viz.—

First year.—Fallow; about one moiety being sown with winter tares, fed off with sheep or mown green for the farm-horses, and then properly tilled. Another small part sown with mangold-wurzel or tankard-turnips; the latter being fed off early in the autumn; the remaining portion left a naked fallow, or sown late with rape or mustard.

Second year.—Barley; drilled on the stale-furrow, without spring-ploughing, at most but scuffled where required, just previous to the drilling.

Third year.—Beans succeed the barley where tares were grown upon the fallows; the other moiety being sown with clover, and so making the clover, beans, and tares to come alternately, but once in eight years.

Fourth year.—Wheat, sown after both beans and clover.

Other farmers, where the land is too tenacious to be safe for barley, drill it only where the green tares were taken on the fallow; the other part being sown either with wheat or oats; but still sowing alternately the clover and beans, taking, as above, the wheat after both.

On the best strong soils, where no conditions of lease interfere, some adopt the six-course system; taking 1st, fallow; 2nd, barley or oats; 3rd, clover; 4th, wheat; 5th, beans; and 6th, wheat. By adopting this system, with a liberal application of artificial manures, the produce of the land is doubtless greater, while no damage need accrue to the farm. It can be successful, however, only where the land is good and well farmed.

The greater part of these soils is so tenacious, that, when in whole-ground, three horses in the plough are often required to break it up. Occasionally, indeed, when extremely hard, even four horses may be seen yoked to the plough as in a double-shaft waggon. Such a statement may shock some, who contend that they can plough any land with two horses abreast. No one condemns more strongly than myself the practice of employing three or four horses at length in a plough, as may be seen in some parts of the kingdom, when two would suffice to do the work. At the same time I am ready to maintain that wisdom neither lives, nor will die, with the man who attempts to plough such land, in the state we have described, with two horses. Least of all can there be any economy in such a practice.

The best strong-land farmers in the county apply horses proportionate in number to the work to be done; but, the soil once moved, you will see them but too gladly adopt in summer the two horses abreast, although, when the land poaches, the horses are placed at length in the furrow; a system which, I hold, is not to be condemned, at any rate until a better is presented.

The Second Class of Soils, named the Gravelly and Sandy Loams.—The largest, and perhaps the best portion, of this description of land, might be thus delineated:—Suppose a gentleman of the Oakley Hunt to mount his steed, start from Oakley House, a little west-by-north-west of Bedford, and take the following route:—Coming out of the park at the Water-mill, and crossing to Bromham; thence, over the Newport road, bearing

off at the Swan, straight away through Kempston, he proceeds down the fields to the edge of the Race Meadow; crosses the Ampthill-road, and so makes his way to Medbury Farm, in the occupation of Mr. Manning. Our sportsman must now keep the rising ground south of Harrowden, and proceed straight on, at the back of Cardington, Cople, and Willington, up to Muggerhanger: he will there reach the highway. Now, let him trot down the road towards Girtford-bridge, till he arrives at Mr. Pawlett's farm, on the right, and on crossing it he might take a bird's-eye view of the beautiful and far-famed Leicester flock belonging to that gentleman. Leaving the farm at Brook-End he must encompass Caldecote, Broom, part of Southhill, Stanford, and Biggleswade, till he reach Stratton Park.

All beyond him, on the east, is nothing but strong land, while on the west lie the fertile lands of Biggleswade, screened from the east and north-east winds by the sandy hills and plantations, and known by the appropriate appellation of "The Garden of Bedfordshire."

A part of Sutton and Potton are convertible soils, as well as Sandy Warren, but more sandy in their texture than the lands he has been passing. Thence his path would lie straight away for Sandy Station, leaving the wild hills to the right and the village to the left, till he reach, by the Great North Road, Tempsford Great House, when on the rising ground, in front, he would see just below him one of the finest views in Bedfordshire, the beautiful water-fall at the point where the Ivel empties its waters into the Ouse. Leaving the park, on the north side, he would cross the home-fields, north of Lamb-cote End, to the small bridge on the Little Barford road, thence down to the river, taking the track of the barge-horses till he nears Little Barford.

He has now to bear off again to the Little Barford road, through the village, and, in order to avoid getting into Hunts, makes his way to Eaton Water-mill. This is his farthest point to the north. There he fords the river, and reaching the Old North Road, turns back, taking in but a strip of land on either side of the Ouse, till he passes Roxton, skirting Great Barford Hill, where the area widens greatly, and with the Ouse again full in sight he bears off on his way to Renhold, fast by Howbury House, over Goldington Green, and makes for the Bedford House of Industry.

Let him keep clear of the town on one hand, and of Clapham Hill on the other, and pursue his journey till he reach the village; then trot round the flat lands of Oakley, back by the river to the point from which he started. The great connected sections of the better kind of gravelly soils of the county are thus, I believe, pretty accurately chalked out. Interspersed along the

ridge of hills, from east to west, there are parishes, and portions of parishes, of convertible land, but more partaking of sand or sandy loam, resting chiefly on the greensand, or sandstone formation: we would point for example to parts of Everton, Potton Sandy, Sutton, Clophill, Silsoe, Maulden, Ampthill, Steppingly, Millbrook, Lidlington, Ridgmount, Husband, Crawley, Aspley, Woburn, and Heath and Reach. The quality of this soil varies from good to very bad.

Upon all this description of soil the four-course system is generally adopted, though not universally.

1st year.—Fallow for a green crop, say turnips or mangold.

2nd year.—Barley.

3rd year.—Clover, red and white alternately, or, where the land becomes clover-sick, winter beans, or peas, alternate with the clover.

4th year.—Wheat.

Cultivation for Turnips, &c.—The most approved system among our more modern farmers is to commence the preparation for turnips in the autumn, as soon after the wheat stubble is cleared as possible; sometimes by the use of "Bentall's broad share" skimming the land about two inches deep, then harrowing and cleaning it as far as the other autumnal operations of the farm will admit. Some, however, prefer the common plough without the breast, and with a broader share made on purpose. By this, with a pair of active horses, they will get over about two acres per day, while they could do only about double that quantity with four horses and Bentall's broad share, and, moreover, with this disadvantage, that when the land gets hard (and you can do no good when wet), the shares soon become blunted, refuse to enter, and missing much, another operation crosswise is required.

It will be proper to add here that when Mr. Bentall first brought out his implement, he had, I believe, cast-steel shares, which, although more costly in the first instance, did the work far more effectually. This practice is not adopted, however, by all our best farmers. Some contend that the broad-share system cuts the couch-grass roots into shorter lengths, making it more difficult to extract, and, after all, leaves a part in the land; they therefore prefer to plough at the same time in the ordinary way, say 4 inches deep, and with the common scarifier and harrows to work and clean the land. And if the whole stubbles cannot be got over, they can manage in a favourable autumn all such land as is intended for the early crops of mangold and swede turnips. This operation can hardly be carried on later usually than the end of September. The wheat-seeding, with the commencement

of October, has to be attended to, and when completed, our farmers again turn to these fallows. Some simply plough them deeper than before, making in all about 6 or 7 inches deep, and so leave them. Others, with far more practical science, plough the *first* furrow about 6 inches, with two horses, and then, with a second plough, without the breast, and with three horses, will subsoil the land from 5 to 6 inches deeper still, by which means they get nearly a foot deep thoroughly pulverized, and in a fine state for a root-crop. The horses following the subsoil plough should walk on the unploughed land and not in the furrow.

For mangold the best practice is thought to be, to lay on the manure after the early autumnal ploughing or broadsharing; the first plough covers it in, and the other breaks the soil below; thus the manure is very properly deposited about the middle of the staple. Where salt is used, about 5 cwt. per acre is ploughed in, a plan which has of late been found highly beneficial for mangold. The other artificial dressing, whether of guano or other manure, is deposited just previous to dibbling or drilling the mangold seed. Some put in this crop on the flat surface, about 2 feet apart; others push the soil into Northumberland ridges at a distance of 27 inches. The writer much prefers the latter method, because the hoeing is always done best and most expeditiously on the ridge. In either way, however, if the farmer be at all liberal with the dressings, and the land be of moderate fertility, and sown about the last week in April, or the first in May, he can hardly fail having a good crop.

Of late, it is certain, that mangold in Bedfordshire is greatly taking the lead of turnips as regards certainty of the crop, and when its properties are fully known it cannot fail to be appreciated.

As far as practicable some of our first-class men follow nearly the same system in preparation for their earliest planted swedish turnips, more especially where they wish to draw a portion from the land. With the ordinary number of farm-horses, however, everything cannot be done in the autumn. Where nothing is done to the fallows till after the wheat seeding, the land is usually once ploughed in the ordinary way, from 6 to 8 inches deep, and so left for the winter; subsoiling not being at present at all general. Real improvements are always a work of time.

In the spring the regular cultivations ensue; some, and I think the best farmers, put in their swedish turnips on the ridge. Others still drill on the flat, generally manuring before the last ploughing, and simply roll the land for drilling.

Rows are generally 18 inches apart, and are done in this county remarkably well, for, after seeing something of many counties, I may say without hesitation that the Bedfordshire

drilling is generally superior to that of any other part of England I know.

All parties very properly adopt the flat system for their late turnips for spring feed. The hoeing of turnips is generally done, first by a judicious horse-hoeing, then set them out a foot apart, as near as may be; if on the ridge, rather closer; and as soon as the dead plants are properly withered another horse-hoeing. Then comes on the flat hoeing, taking out any double plants which may have escaped.

The last horse-hoeing will generally be effected close upon the edge of harvest, and occasionally after the harvest has commenced. Our cleanest farmers also send a man over them once more after harvest, to extract any fibres of couchgrass that may still be alive —an *excellent practice.*

Failure of Turnips.—It would be improper not to notice here a fact which is notorious: that within the last few years there has been a great failure of turnips in the county, more especially 1855; and most of all on what has heretofore been regarded as the best turnip soil. For on the chalk-bottom lands the disease, where it prevailed at all, was by no means virulent. The failure has not arisen from the ravages of the common turnip-fly or beetle, but rather from a complication of disorders. The principal disorder is what, in the eastern part of the kingdom, is termed "Anberry," in others "Graping," because the turnips so affected throw out certain protuberances resembling grapes, in which a small maggot is generated, ultimately becoming a flying insect. Other parties term it "the finger and toe disease," on account, it may be, that there are often a number of these grapes, or perhaps more properly warts, at the lower part of the turnip, growing out of each other, resembling toes or teats, to which is attached a small root; but from the diseased state of the turnip it cannot take up nourishment from the soil, so that you may easily kick up the turnips. In fact, they are worthless, for should they attain any size before they are attacked, they decay before they can be eaten.*

In addition to the above, the mildew of the last season upon all the early-sown turnips was singularly severe, superinducing, it is believed, other diseases. Thousands of acres were this year attacked, while the mildew was upon them, with swarms of lice or flies of a light-green hue. In the first instance they appeared only in small patches, but soon extended over a considerable

* I trust it will not be improper here to say, that, in the opinion of many practical farmers, as well as in my own judgment, Professor Buckman, in his late treatise, appears to have mistaken the disease in question, for in all the specimens he has given I do not see one representing the disease of which we are treating, but *simply roots which are the production of degenerate seed.*

portion of the field. It is true they were short lived, but they lived long enough to poison the plants, for very few made further progress.

Most probable cause of Disease.—In Norfolk, whenever turnips anberry, which is frequently the case upon very loose light land, the farmer concludes that the land must be clayed. But in Bedfordshire the thing occurs on many of the very best gravelly loams of the county, and has done so more or less for some few years past. That it is not the result of atmospheric influence is evident, for in a field, near Bedford, I recently saw, up to a given point in the same field, a part wretchedly diseased, while those adjoining had pretty well escaped. It turned out on inquiry that when the field was last in turnips the part which had now escaped was in mangold-wurzel. It appears, therefore, tolerably certain that land may not only become "clover-sick" (as it is termed), but turnip-sick too! It would seem that the too frequent repetition of turnips, if not the chief cause, at least favours the disease.

The case above cited is only one out of many illustrations that might be given; and the exemption from disease on the chalky soils is a still further corroboration, for in that division of the county the turnips come less frequently, because the farmers generally adopt the five rather than the four course system of cropping. It becomes therefore a grave consideration, whether the restriction to the four-course system in many leases and agreements, should not, for the public benefit, undergo some modification, more especially as regards the better land of the county. For, what is the use of chemistry, or the discovery of valuable artificial manures, in such cases? The best farmers, by their common management on these lands, can and do keep up the condition of their farms to the growth almost of as heavy crops as the land can bear. Moreover, if the fourth part of all such farms are, *ad infinitum*, to be left in fallow, or a green crop, and not an acre more corn to be grown, how are the wants of our increasing population to be met? Surely these leases and agreements are, some of them, an impediment to progress and a clog upon the wheels of agriculture. They tend to retard, when they ought to promote, improvement.

As our instructions require us to suggest any changes that are needed, the better to carry out the objects of the Society, I shall not be travelling out of the record by saying that the reconstruction of the covenants of many farm leases is imperatively called for. Meanwhile, I would also suggest that a fair representation of the case should be made to the landlords; and that, pending this, the system be changed on the turnip fallows, dividing them into three compartments—mangold-wurzel, turnips,

kohl-rabi, cabbages or rape. I place them in the order in which they ought to be put in. These must alternate season by season.

There is, I am aware, a still prevailing prejudice against mangold; but, if I mistake not, it is utterly groundless, and must arise from ignorance of the proper mode of using it. Of turnips, perhaps, nothing need be said beyond the suggestion that where there is a decent subsoil farmers need not be alarmed at fetching it up. Let the experiment be tried on a piece of fallow, on a small scale, if you please, by ploughing two furrows deep, instead of subsoiling; thus procuring from 9 inches to a foot of staple, according to its quality. The writer has done thus with success, both for turnips, mangold, carrots, and potatoes. The virgin earth, thus fetched up, after an exposure to the frosty atmosphere during the winter, will mix admirably with the old cultivated soil. The prejudice against kohl-rabi is perhaps still greater ; but let it be remembered that, in the first instance, the prejudice was scarcely less against Swedish turnips. The root I am recommending, it will be remembered by some of our readers, was introduced into the county by the late John Foster, Esq., of Brickhills. The writer grows them. He has, this year, seen as fat sheep turned out by such means as any butcher would want, and the bulbs are still sound, while the Swedish turnips, close at hand, are more than half rotten. For further evidence as to the fattening quality of kohl-rabi, reference can be had to the Messrs. Bowyer, of Hunts ; or to Mr. Pawlet of Beeston, the successful breeder and feeder of Leicester rams. Of rape I need say nothing; one great benefit of substituting kohl-rabi and cabbages for turnips as a change is, that they (the kohl-rabi and cabbages) may be planted after a green crop. The seed-bed of both must be sown tolerably early in the spring, and may be planted out after the green crop is fed or mown off. By using the skim coulter, one ploughing will suffice. Of course this portion of the fallows must be cleaned in the previous autumn.

Before I quit this division I should just say that there are dotting the county from east to west some small patches of extremely wild sand, commencing with Sandy Warren on the east, where cultivation may now be seen climbing the hill-top. This is nearly the last piece of barren land to be reclaimed in the county. At Maulden, Ampthill, and Milbrook there are spots of the same kind, finishing at Heath and Reach on the west, which are also yielding to the hand of cultivation.

There are some important strips of land not exactly comprehended under either of the heads we have enumerated, namely, the parishes, and portions of parishes, which lie between the clay and the gravelly loams, and that lying between the latter and the

chalky division, and which, by-the-by, is some of the best land of the county.

The *Third Division* of *Soils* are those mainly of a loose and chalky character, lying upon the oolite or chalk formation.

This land, situate on the southern extremity of the county, is bounded by Hertfordshire, and runs along to Chiltern Hills. At the foot of these hills the chalk formation continues for some distance, although, along the valley, the hard rocky chalk is generally covered to a greater or less depth with some drifted chalk, or gravel with an admixture of chalk. This gravel, though so used, makes very inferior road materials, being, from the chalky admixture, always adhesive after frost and rain. This also accounts for the highways in this district not being so good as in other parts of the county.

In the middle of the county we have shown that the roads are excellent; and in the northern division, having no gravel, or next to none, they purchase it from a distance, and of course purchase the best, whilst in this chalky district, having gravel, although of inferior quality, they are induced to use it, rather than purchase and fetch it from a distance. The roads in this chalky district are improved, however, by gathered flints from the stiffer soils.

On nearly the whole of these lands, from the south-east to the south-west boundaries, turnips are cultivated more or less, though on the higher parts of these hills there is often to be found a bed of flinty clay, between the surface soil and the chalk, which, of necessity, renders it ineligible for turnips. Still, there are only partial spots of this division of the county that require draining. In the absence of this clay, where the rocky rubble approaches within 3 or 4 inches of the surface, as it does in many places, the land is naturally extremely poor and unkind for all green crops. It is most productive, however, of charlock and other noxious weeds. One of these is the common pig-nut (*Bunium flexuosum*). It is rarely found excepting upon this description of land. The bulb is very peculiar, both in its formation and mode of propagation. The seed, which drops from the stalk, and gets covered in the soil, becomes a small bulb, which, as it produces its seed from year to year, increases in dimensions until it attains the size of a moderate potato. It assumes a brownish colour and an irregular shape, but is remarkably tenacious of life; for, when harrowed out of the land, and exposed to a scorching sun for days, unless eaten up by pigs or sheep, when covered in the soil it again vegetates. A few years back much of this land was not considered worth cultivation; it lay in a sort of sheep-walk of the most ordinary kind. Indeed, a part of the Dunstable and Totternhoe Downs still remains. At

the time of Mr. Stone's Report to the Board of Agriculture, there was scarcely any meat produced in this division of the county. The chalks being naturally unkind for turnips, (swedes scarcely ever being attempted,) the few patches of the common sorts that the farmers managed to grow were wanted to keep the ewe flock, whilst the produce bred were usually sold to be fatted in other districts. Artificial manures for turnips were not even thought of, and stall-feeding was out of the question; for the best of all reasons, viz. that the farmers had nothing with which to fatten bullocks.

The crop of clover, save that eaten by the farm-horses, was usually sent to London, as also the greater part of the wheat-straw. A black substance was brought back for the wheat crop, commonly called *soot*, but it comprised all manner of gatherings which the manure-dealers could manage to scrape together, "provided always" that a little of the *real thing* was retained to preserve the smell, and to give it the right colour. Thus for many years were the farmers of South Beds and North Herts cheated. It is, therefore, no wonder that the produce of the land was most meagre.

In a village near Luton the writer has been credibly informed that, about the time above alluded to, only one wheat-stack was attempted throughout the entire village; and that, it seems, was but an apology for one, the walls being made of wheat, and the roof made up with peas. In this place, however, there may now be seen beautiful waving crops, and the fields and stack-yards studded with stacks.

It is but justice to say, however, that where the drifted chalk, or gravelly chalk, intervenes between the upper staple and the chalk rock, this land, with good management, is very far from being the worst of the county. Indeed it must be classed among our most certain cropping lands.

In the southern district an excellent practice on this description of soil is to have growing about one-eighth part or thereabouts of the arable land in sanfoin, to be changed after one course of cropping. It is much more certain than clover to produce a good crop of hay on the chalks, while the eddish after the scythe is the most wholesome and forcing food on which the farmer can wean his lambs; added to which (and that no trifling advantage), there seems to be no affinity between sanfoin and red clover, for after you have broken up the sanfoin, and brought the land into a good state of tillage, it will forthwith bear good red clover.

It has already been shown, that the farmers generally through this district, after laying on a dressing after the wheat crop, add a crop of oats before the fallow, thus adopting the five-

course system, and, strange to say, either from the less frequent repetition of the crop, or from the chalky nature of the soil, the turnips mostly remain good, while in other parts of the county they have miserably failed.

Improved turnip cultivation of late years has doubtless been at the foundation of these astounding advancements, and our South Beds farmers are much indebted to the indefatigable and scientific exertions of John Bennet Lawes, Esq., of Rothamsted, in the preparation of a description of turnip-manure, which has performed wonders throughout the whole of these chalky districts, which heretofore were most ungenial for the growth of all root crops. It is true, that, by the partial use of broken rape-cake and other artificial manures, improvements had commenced a few years before that gentleman commenced his experiments, but the great desideratum was still absent, viz. a manure that would force the turnip plants in the early stages on those ungenial soils without endangering the vegetative properties of the seed. This result Mr. Lawes has accomplished, and instead of witnessing now, as heretofore, large patches of land completely naked and others covered only with a few stinted worthless plants, you may witness on the farms of the more spirited agriculturists, field after field, a fine uniform crop, exceeding in many instances that of the more kindly soils of the kingdom where no such appliances are used.

In the cultivation of turnips in this part of the county, the ridge system (except for their late turnips) is almost universally adopted by our best farmers. They use their farmyard manure, so as to supply a portion for the whole of the turnip fallows, and then, after the manure is covered in, from 3 to 5 cwt. per acre of Lawes's superphosphate is drilled with the seed, and if, during the operation, sufficient moisture is retained to cause the seed to vegetate, the turnip crop is considered safe. Such indeed have been the effects of recent management in this part of the county, as to have in many cases doubled the production of human food within the last thirty years, and if you go back to the time of Mr. Stone's Report in 1794, it has doubtless been quadrupled.

Meadow and Pasture Land.—Hitherto there has been but a cursory allusion to the grass-land, nor need our remarks be at all voluminous, as the pastures of the county are not extensive, nor generally of first-rate quality. There are, however, a few exceptions:—

At Pulloxhill, near Silsoe, there are some fields of very good grass, such as will fatten a bullock well, and is not thought less eligible for dairy purposes.

At Marston Moretain, the far-famed Church-close or closes is very fine bullock land, while the Horse-craft field, the Holms, and

fields adjoining, are among the very best pasture grounds of the county.

The best portions of Lidlington are scarcely inferior to the former. This farm, a few years since, was regarded as the first grazing farm in the county, and was admirably situated, having springs arising at the foot of the sand-hills, whence the water could be directed through nearly every pasture-ground of the farm.

Within the last ten or twelve years the proprietor (the Duke of Bedford) has allowed much of the second-rate quality to be broken up; a boon which could hardly fail to be appreciated by his tenant. There are also some very useful pastures at Rockliffe, Battlesden, Toddington, and Potsgrove, with the enclosed portions of Woburn Park. Silsoe Park also, under the management of Mr. Mason (Earl de Grey's farm-bailiff), has within the last few years been greatly improved. At Bromham also, and the great bulk of the meadows beyond, up to Turvey, are pastures of a very useful, not to say first-rate quality.

The other meadows adjoining the Ouse, quite through Bedford, and down to Eaton, are generally weak. A portion, however, being laid pretty well to all the adjacent farms, they supply a quantity of useful meadow hay, without cost of manure to the farmers, and are, therefore, very properly regarded as a valuable adjunct to the farms.

Through the whole of these parishes there are a few good dairies kept, the butter being sent to London. In the remaining parts of the county a few dairy cows are kept, principally to supply the family.

The meadows of the "Ivel" are very inconsiderable, both as to quantity and quality, and those of the "Lea" are still more so. This river takes its rise at the foot of the chalk hills, between Dunstable and Luton is bounded by poor arable land, and makes its exit very shortly at New-Mill End.

Of artificially made water-meadows there are but very few, save those of the Duke of Bedford. At Woburn there are some very good ones, which his Grace principally holds in hand; they appear to be nicely kept up, and of good quality. There are others at Flitwich and Maulden, which were made at considerable expense some years since, but, being on a peaty soil, the produce is exceedingly coarse, and the hay is of very middling quality; they are held by his Grace's tenants, Messrs. Overman and Platt.

In this county there is but a narrow strip of peat land lying south of the Ampthill range of hills, and that of very moderate quality, running from Tingreth through Westoning, Flitwich, Flitton, Maulden, and Clophill. In its natural state it is full of water, and, when drained, the soil is so sulphureous, that it is not worth

much in grass, and still less under tillage. Here and there are spots that will grow mangold, but of corn there is no certainty.

The whole area of the county, as observed in the introduction, comprises about 296,320 acres. The Editor of the 'Parliamentary Gazetteer' makes the pasture more than twice the quantity of the arable land. This is probably a typographical error, as there must be fully three acres arable to one of pasture. I do not pretend to the strictest accuracy in this matter, as there is much of the inferior grass-land every year being converted into tillage. But from the best information I can collect, the following, I believe, will be found tolerably correct:—

Of arable, say	210,320	acres.
Upland grass, meadow and commons	70,000	,,
Which leaves for woods, wastes, roads, and waters	16,000	,,
Total acres	296,320	

Population about 130,000, the larger portion of which is employed, directly or indirectly, in farming and gardening pursuits.

The climate is generally considered healthy, not less for stock than for the human family, and very favourable for the growth and maturity of corn. The mildew, which formerly much affected the low land crops by the rivers, is fortunately now, from what cause I know not, much less frequent.

The Bedford vale (as it is often termed), running south-east by east, is justly regarded as the finest portion of the county as a farming district, in which are also to be found some of the finest market-gardens of the kingdom.

The Great Northern Railway, which runs through the heart of these market-gardens, has proved a most valuable acquisition. The direct Leicester to London, *viâ* Bedford and Hitchin, will complete the accommodation both in the carriage of their goods and supply of manure. During the spring and summer months, this is by far the most interesting part of the county. To see the hundreds upon hundreds of these enterprising and industrious men, working in their little well-cultivated plots, from dawn of day till night, is, to strangers in particular, a most interesting spectacle, while it is quite astounding to learn the amount which this busy hive will sometimes extract from an acre of land.

The *Stock* of the county has scarcely less improved than its agriculture.

The farm-horses have improved, but not perhaps in the same degree as the neat-cattle and the sheep. There are a few studs of good Suffolk horses, but generally our farmers are not particular as to the breed and colour of their farm-horses. The proportion of sward, or low grass-land, being small, there

are but few bred in the county. The majority of our farmers buy them in as colts; when fit for the collar, work them a few years lightly, and make them up for the London brewers. Others purchase them at from three to four years old, and, if good and kind workers, keep them on till they have done their best.

A third practice, and I think by no means the worst, is to keep some good mares among their working horses, and breed a few foals every year. The mares are indulged a little as they get forward with foal, and after foaling, two mares are required to do the work of one horse until the turnip-sowing is completed, when they are rested till after harvest. The foals are now soon weaned, and the mares are again put to general work during all the autumnal cultivation, when, if breeding again, their work is lightened during the winter months. By such a system, making choice of some powerful, clean-legged mares, the farmer manages to keep his team young, while he scarcely feels the keep of his colts, and avoids any outlay for the purchase of horses.

The writer is inclined to think that a good judge in breeding horses, by selecting mares of good constitution, and kind workers, secures by the above plan a good team, and makes the best return. It is proper to say that the general character of the farm-horses, within the last half-century, has greatly changed. The hairy-legged black horses are nearly extinct, and a more active race have succeeded.

The common practice in the county is to work their horses only one long journey in the day. But on the turnip-land farms, during the summer months, our best farmers have recently adopted (and wisely so) double journeys, by which more work can be accomplished and with less fatigue to the horses.

The *Neat Cattle* are principally of the short-horn breed; His Grace the Duke of Bedford, however, still keeps a fine herd of Hereford cows, from which he breeds some very useful steers, makes them up at about three years old, and with others purchased in the West of England, makes an excellent annual fat stock sale, a popular resort of the butchers for their Christmas beef.

On the farm of Mr. Thomas of Lidlington, and a few others, more of these fine white-faced animals may be seen grazing on the better grass-lands; but they are principally purchased, not bred there. On a rough estimate, we should take the short-horns bred in the county to be numerically as ten to one of any other breed.

From its small extent of grass-land, Bedfordshire is by no means a breeding county. Where cows are kept, there has of late been great anxiety to obtain the use of a thoroughbred short-horn bull, by which the home-bred steers are greatly im-

proved. It must be generally known, however, that we have here a few eminent short-horn breeders, whose herds are well known within the circulation of the Agricultural Journal. Take, for instance, those of Charles Barnett Esq., John Crawley Esq., of Stockwood, Earl de Grey, and Mr. Fowler of Henlow, &c. &c.

Young bulls have been, of late, selected from these herds to the great benefit of the neat cattle of the county. Indeed, animals so bred will occasionally, when fatted, put to the blush some of our first-class breeders; whence the question legitimately arises, whether these gentlemen, in their great regard for symmetry, do not sometimes sacrifice qualities of still higher value.

The *Sheep* of no county within the last sixty years have been more extensively improved than those of Bedfordshire. In Mr. Stone's Report of 1794, to which I have previously referred, they are thus described:—"The sheep of this county are of no distinct breed; the horned and polled species are often kept in the same flock; are coarse in their head, large in their bones, high in the leg, with picked rumps; narrow in the bosom and chines, and with an indifferent quality of wool, weighing from three to four pounds only per fleece." Some exceptions are then alluded to. "Francis Duke of Bedford was trying some useful experiments as to the comparative value of the different kinds of sheep; and Mr. Bennett, a farmer of Tempsford, on the Great North Road, had possessed himself of a breed called the 'New Leicesters,' which are doing infinite credit to his judicious choice and perseverance to obtain, requiring no mean judge to distinguish them from those of the first breeders in Leicestershire."

From this flock it is well known the excellent sheep of the late Messrs. Sandon and Inskip, with many others in the surrounding counties, were descended. Rams selected from such a flock, with wide frames, of great symmetry, and with aptitude to fatten, would be likely to produce, as they did, when put to the ordinary bred ewes of the county, the most astonishing improvements.

From these facts it is not difficult to account for the eminence to which many sheep-breeders have here for many years attained. They are often second to none in the kingdom for Leicester sheep. It will be admitted, however, that it is now no easy task to maintain that superiority. Of late there has been a great rage for crossing the breed of sheep. This arises from a deep and prevailing impression, that the neat and delicately formed Leicester rams, which half a century ago so completely revolutionised the barbarous flocks of this part of the kingdom, when bred in and in, are not now the most profitable to the farmer.

The consuming public also complain that there is too great a proportion of fat to the lean. To obviate this evil some have crossed with the South-Down ram, and with the first cross they obtain doubtless very useful sheep; but ultimately, in progressing, they lose weight of wool, aptitude to fatten, and general evenness of character. Others have crossed with the Cotswold ram; but however good the produce, when these sheep are put to Down ewes, they seem to mix worse with Leicesters than any other sheep. The wool becomes hairy, and the good properties of both breeds seem to be lost, while the flock never keeps up its condition. Attempts have also been made in this county, as in Oxfordshire and Hampshire, to rear a distinct breed of sheep, dark in the face and legs, with a tolerably fine fleece, and in weight nearly equal to the Leicesters; and certainly some good butchers' sheep of this character have been produced. But being originally a cross from two distinct breeds of sheep, very diverse in character, there is much difficulty in preserving anything like uniformity in the flock, and the same aptitude to fatten as in the best class of long-woolled sheep; so that hitherto in Bedfordshire they have not greatly extended.

Another portion of our long-wool breeders, and they are not by any means the most shortsighted men, have of late been using sheep on their Leicester ewes, from the best breeders of Lincolnshire, such as the Messrs. Kirkham and Caswell, by which they have increased the size and muscular properties of their sheep; have more wool, and, I think, without losing an iota of their aptitude to fatten. These sheep, compared with Leicesters, are far less diverse in character than any other description of sheep, and consequently mix better than any other cross (if cross it can be called). It must be observed that the sheep we have referred to, though bred in Lincolnshire, are very different from the general breed of Lincoln sheep. By breeding carefully between the Leicesters and the above flocks, the most profitable rent-paying sheep are produced.

There are still some excellent flocks of pure Leicesters bred in the county. And among those to whom the public are indebted for their efforts to preserve their distinctive breed of sheep, Mr. Pawlett must now be regarded as standing foremost; as the recent awards at the Royal Agricultural Society and elsewhere amply attest. There are also a few flocks of pure South-Downs: among others, those of his Grace the Duke of Bedford and his tenant Mr. Thomas stand deservedly high. With so much variety produced in a county long proverbial for its superior sheep, it is to be sincerely hoped that the reputation gained will not be lost.

Improvement in Ploughs and General Agricultural Machinery.

—At the period of Mr. Stone's Report, viz. 1794, there was scarcely any save the old Bedfordshire wooden plough, with one handle fixed and the other loose, the latter handle used at will as a spud or cleaner to the plough, the whole being of the rudest construction; the breast or mould-board was made of wood, without the slightest reference to the form in which the furrow-slice should be turned over; so that, after being cut through with the share, if the ploughman happened to be finishing his land or ridge, and the ground were at all elevated on his right, it was not uncommon for the furrow-slice (when in turf) to fall back into its original bed for chains together. The ploughman, under these circumstances, leaving hold of his plough, had to run back, to stop, if possible, its progress. This need excite no surprise, for the plough merely formed a wedge, raising the furrow to a given point, leaving it to the mere chapter of accidents which way it would fall. Indeed, the author of the 'Bedfordshire Survey' was himself so wedded to the old wooden plough that, as late as the year 1821, he was confronted on his own farm with a Ransome's L. L. plough, which put Mr. Bachelor completely into the shade, both as regards the superiority of the work and the lightness of draught, as tried by a dynamometer, notwithstanding that the modern implement was double the weight of the old wooden one.

It is but justice, however, to say that Mr. Bachelor's brother, about this time, constructed a very strong plough for the clay-land of the county, and which would plough it in its hardest and most sterile condition. This implement was made with a strong wooden beam, iron neck and breast, with two wheels, and was certainly a great improvement on all previous Bedfordshire ploughs. The inventor won several prizes with this plough at the annual meetings of the County Society. It was, however, subsequently beaten, both by Ransome's and Howard's iron ploughs; and here it is just that we should make mention of the extraordinary success which the Messrs. Howard of Bedford have met with of late years with their patent iron two-wheel plough, which has made its way into every county in England, and numbers have been sent abroad. Their harrows and steel-tined horse-drags are scarcely less appreciated. It would not be right, however, to pass over other very good ploughs that have been recently constructed in this county, such as those by Mr. Taylor, Mr. Williams, and Mr. Hensman.

The last-named gentleman was the inventor of the simplest and best coulter-fastener we have yet seen. Indeed it may be said that no county in England can now boast of better ploughs or of more skilful ploughmen. To say nothing of the scores of local ploughing-matches where these ploughs have proved suc-

cessful, the annual meetings of the Royal Agricultural Society for the last ten or twelve years afford the most ample corroboration of the statement. The Bedfordshire harrows and drill are scarcely in less repute; the latter more particularly where straight drilling is at all appreciated. Mr. Hensman, of Woburn, is now the manufacturer of the drill, as also of a good steam thrashing-machine.

The late Mr. James Bachelor, brother to the author of 'Bachelor's Survey,' was, however, I believe, the first inventor of the Bedfordshire steerage lever drill, and for many years was a very ingenious tenant upon the Bedford estate.

The corn in this county is nearly all drilled, excepting a few beans and a little wheat, which here and there are put in with the double dibble.

The hoeing of all corn (except wheat) is considered good husbandry; but farmers of most experience will not hoe that crop unless the quantity of weeds renders it imperative.

Our farmers have not yet attained to great uniformity in the mode of harvesting their corn. Some still reap all their wheat, and others only their heavier crops, mowing and tying the rest, as also their general spring crops, but the latter are not generally put into sheaf; to do so is, at any rate, rather the exception than the rule.

They generally use one-horse carts in carrying their corn, and insist that, unless the distance be considerable and roads bad, they can do it more expeditiously than by the use of waggons. The ancient practice was to bring all the corn home, however far from the homestead. Of late they stack more at large. In many parts of the kingdom the more modern system is to stack the corn where grown; but this in our judgment is a system as far from the correct one as that of cramming every stack into the stackyard. The better practice is, we suggest, to bring the great body of the corn into three or four distinct groups of stacks, within a very easy distance of where the straw has to be consumed.

This brings us to the question of

The best mode of Thrashing.—The practice in Beds, previous to the use of steam, was to move every stack into barn before thrashing it, but of late some few of our farmers have adopted the Norfolk system of stacking anywhere, and thrashing the stack at the same place, which we hold to be a wasteful system. And for these reasons. First. If the straw is ultimately to go to the farm premises, to be made into manure, it cannot be moved so cleanly and easily as when in the sheaf. Besides, it is a difficult task to clear up and move all the offal when broken into fragments, and it is often left to be cleaned up at some less busy season, which frequently does not arrive till the offal becomes

an eyesore, while by fetching home the straw, a load or two at a time, repeated litterings are made when one might have sufficed. In addition to this it is not at all uncommon to see the straw blowing over the fences and fields in all directions. Meanwhile we have said nothing of getting home the corn and chaff, the latter being generally wasted. I am happy to say that, although steam-thrashing is getting much into use, there are but few of our farmers disposed to follow a system which we have thought it right thus to reprobate.

Our more judicious men either previously move the stack into the barn, where it is safe from bad weather, or, setting the machine pretty close to the barn, move the stack at the time of thrashing, and so put the thrashed corn into barn, the offal into the farmyard (the proper place for it), and stack the straw most conveniently for future use.

That portable engines are very convenient there can be no question, particularly until farmers avail themselves of a fixed engine on their own occupation, but I am strongly of opinion that on all moderately sized farms it is far the most convenient plan to have a smaller fixed steam power to do the grinding, chaff-cutting, cake-breaking, &c., in addition to the thrashing. I repeat, that in the present emergency it may be good policy to use these hired steamers, but the object of the owner must be always to earn money; there is consequently far more lumbered out in a day than at all comports with the convenience of a moderate sized farm.

System of making the Manure.—The practice varies so greatly even among good farmers, that it is no easy task to state the best. All real business men are, however, agreed, that herein lies the great secret of farming, that is, not how to make manure at the greatest profit, for profit is out of the question, but how to make the best manure at the least loss. This question embraces so many points that it is highly difficult to know where to begin. There are first the right sort of animals, and the right position in which to keep them during the time of fattening; whether in the farmyard, and if so, should the yard be covered? or whether in the stall, or in boxes? These are all, in themselves, important questions; and then add to these, What is the least expensive food? at the same time keeping up the quality of the manure.

The late Mr. Samuel Bennett, of Bickerings Park, was among the first to adopt rather largely the system of box-feeding in this county, and he made some very fine beasts, but how far it paid him to erect his boxes, which he did himself at considerable expense, we have no means of ascertaining. The manure, it was said, always produced great effect.

His Grace the Duke of Bedford, who is one of the largest winter graziers, has for many years adopted stall-feeding, but of late has used boxes; and Mr. Baker, his Grace's farm-bailiff, generally exhibits well-fed beasts. This gentleman gives a decided preference to boxes, but more from the saving of labour, and from the superiority of the manure, than from any decided increase of the flesh of the animals over those fed in stalls. In the former, moreover, the animals have always been healthy. Mr. Thomas, of Bletsoe, after five years' experience of box-feeding, says his cattle always do better thus than when tied up by the neck. He consequently always keeps his boxes full while he has any beasts left. He makes it his practice to have them twice littered per diem, and has the litter from the sides regularly levelled under the animals, by which they are kept clean and healthy. He also considers the manure so made 25 per cent. better than that made in stalls and thrown out into the yard. This gentleman is a great advocate for covered farm homestalls, and thinks that when the farm buildings are first arranged such need not be much more expensive.

Mr. Thomas, of Lidlington, an equally experienced grazier, feeds in stalls, because he has no boxes, else he would gladly adopt them. He decidedly prefers either plan to that of fattening in the yard, with hovels attached. He asserts with confidence that in yards the animals consume more food, and make considerably less progress. Where straw, however, is very abundant he finds it necessary, in order to get it all made into manure, to keep his growing store beasts in yard, but takes care to give them good food.

The practice of many other good farmers might be cited. The writer, however, regards the subject as sufficiently important to warrant a suggestion, that the Royal Agricultural Society should get some well-attested experiments made on this subject.

Labourers' wages in the county of Beds are, I think, about the average of the kingdom, or somewhat above that average, if the perquisites in kind be added to the payment in money. They are not so high, generally, as in Lincoln and Yorkshire, but far higher than in the west of England; and the labourers are consequently, I believe, a more active and industrious class.

The common day-labourers' wages vary from 9*s.* to 12*s.* per week. During the late advance of provisions they have attained the higher point, while the horse-keepers and shepherds have about 2*s.* per week in advance of this. The labourers have, for the most part, small beer during the greater part of the year; but in the busy months, and when at very laborious work, they have ale furnished in addition. Harvest wages are, generally, about double those paid during the other parts of the year.

The more considerate of our farmers manage, as far as practicable, to give piece-work to men of large families; so that men, so circumstanced, have the opportunity of earning more money, and their wages will often reach 15*s.* per week; while to this must be added frequently the earnings of other members of the family. In the southern division of the county the plaiting of straw furnishes additional employment to the wife and junior members of the family, and a most welcome addition to the income of the household.

Many labourers have garden allotments, and when these and the cottages are at a moderate rent the labourers are not ill cared for. But, I regret to say, this is not invariably the case, and full justice can scarcely be done to the farm-labourers of the county, or to some of their best friends, without appending a few remarks on cottages and cottage allotments, for the sake of a deserving but too often depressed portion of our rural population.

It is scarcely needful to say that to a family-man, be his condition in other respects what it may, if there be the absence of convenience and comfort at home, there cannot be real enjoyment of life. In the course of a new assessment of a populous parish in the county, I have seen, on the one hand, labourers living in miserably small and crowded cottages, devoid of all convenience, and without a foot of garden ground, paying a rent of 2*s.* 6*d.* per week, or 6*l.* 10*s.* per annum; while, on the other hand, in the same parish, were to be seen tastefully built cottages, often with three sleeping rooms and two rooms below, fitted up with a neat stone sink, a supply of spring and soft water, and a good spacious garden studded with fruit trees, and all for about 3*l.* 5*s.* a year, or at most 3*l.* 10*s.* per annum.

The former were, it appeared, the property of a speculator, who, taking advantage of the wants of this class of poor people, bought ground and erected a number of cottages on the most economical plan, with but little reference to comfort. They are, however, tenanted; and upon the maxim of Hudibras—

> "The value of a thing
> Is just as much as it will bring"—

the rent-collector is sent round every Monday morning for his half-crown, or, in some instances, three shillings, which must be paid within the week.

In the latter case the property belonged to a nobleman, whose estate in that particular parish is not large, but who, doubtless, feels a just pride in providing comfortable homes for the labourers working upon his estate.

The want of comfortable cottages, and as near as possible to

the scene of labour, is in many parishes a crying evil. The wear and tear undergone by a labourer in traversing three or four miles a-day, to and fro, in addition to his toil on the farm (as is commonly the case) is a most heavy drag upon the living machine. It might and should be obviated, by the erection of suitable cottages in the immediate vicinity of farms lying at a distance from the village, and where there is but little difficulty in attaching a sufficient plot for a garden.

Allotments to Labourers for the growth of their vegetables, &c., when judiciously and liberally carried out, are doubtless an essential benefit, and since the date of Bachelor's Survey have become more or less general. A large portion of the labourers, where the soil is at all suitable and let at a moderate rent, occupy them well. In other instances it is exactly the reverse. You may occasionally see a tract of poor clay land, set out at a considerable distance from the village, and at a rent double its worth for farming purposes. The consequence is, in such cases, that if the land was worth anything previously, yet, after the lapse of a few years, its annual value for a long subsequent period might be reduced to a cipher, and the farmer has to take it back in a state of wretched impoverishment. In some few instances I have seen the glebe lands so appropriated, and it would be charitable to hope with a benevolent object, but under circumstances that could hardly fail to render it an utter abortion; for it is possible that good intentions may be spoiled by the manner in which they are performed. It is quite true that a gentleman cannot allot land more convertible than that which he possesses; and the great proportion of clay land, which abounds in this county, is a barrier to the fullest and most salutary operation of the allotment system. Small portions of moderately strong land, well drained and in convenient situations, may be so applied; but any considerable quantity of this kind of land only harasses the labourer, without yielding any corresponding benefit; indeed, about a rood of the more *temperate soil* is found to be about as much as a labourer can well attend to, consistently with his duties to his master, and quite as much as he can keep in good condition. In all cases *situation* is scarcely secondary to rent in point of importance.

If judiciously carried out by men who sincerely desire to benefit their workmen, these allotments cannot fail to promote the comfort and well-being of a class of men whose interests are identified with the interests of all, and whose improvement should be the aim of all.

In conclusion, a comparison of the past with the present cannot fail to show that the county of Bedford has made within the present century no small progress in Agriculture. But, in

order to assist the reader to form a still more definite judgment, I may be allowed a brief recapitulation.

Begin, then, with the days of Lord Somerville and Sir John Sinclair, those well-known patrons of agriculture, and what do you see? About two-thirds of the county in a state of common or open field; a third of the arable land, whether convertible or clay soil, under a dead fallow every year, while the part considered to be under crop was woefully damaged by water. The sheep, generally meagre-looking animals as they were, were often swept off in entire flocks by the rot. The neat cattle were of no distinct breed. The farm-horses were rough and hairy about the heels, and admirably adapted to carry along with them, on every leg, some stones of the wet tenacious soils they had to plough. The farm implements were of the rudest kind. A little mutton, it is true, was here and there produced in the summer on the best grass-lands; but in winter there was scarcely any, and still less of beef. The manure (if manure it might be called) was little else than a quantity of decomposed straw, scarcely worth the cost of carting on the land, and producing the most wretched crops. Such is the summary, and a tolerably just one, of the farming of Bedfordshire at the close of the eighteenth century.

To exhibit the contrast most vividly would be best accomplished by ocular demonstration on the farms of some of the best agriculturists of the present day. Let it suffice, however, to say that there are scores of farms now producing 50 per cent. more corn than in 1794, and supplying the metropolitan markets with a stone of meat for every pound supplied at the former period. To what, then, are these vast improvements, which now everywhere present themselves, to be attributed? To the solution of that question the closing observations of this treatise shall be directed.

It has been said of some men that their friends lived before them. With perfect propriety may the axiom be applied to the agriculturists of Bedfordshire. Master-minds have preceded them. No one that lived in the days of the first Francis Duke of Bedford can be ignorant of the efforts which that nobleman put forth to arouse the torpor-stricken agriculturists of his day. He was cotemporary with Mr. Coke of Norfolk in the earlier days of that eminent agriculturist, and in all matters of agricultural improvement was a man of kindred spirit. He vied with that gentleman in establishing his annual agricultural gathering at Woburn with a noble munificence, and he continued those meetings to the day of his death. The spirit of improvement, however, survived him. His brother and successor, John Duke of Bedford, continued to aid the cause of agriculture in

every form by his influence, example, and kindness, not less than by his princely rewards to improving tenants.

The County Agricultural Society was now formed, and it is but justice to say has ever since been supported by the House of Russell with the most liberal donations. It is also gratifying to find that, within the last few years, the Society, since it commenced its perambulatory meetings, has become more healthy and vigorous. There are, no doubt, in every hive some drones to be found, and in every county some men without energy, spirit, or enterprise, and whose principal usefulness consists in making a dogged indifference to improvements the more ridiculous. Such men are like accumulations on the coulter of the plough; and as time, like the ploughshare, passes along, it will doubtless dash them aside.

These Societies have been of incalculable benefit to the community in general, but not to any county more than Bedfordshire. They have imparted a spirit of emulation to young men, which has not been lost upon the present generation of farmers, and which augurs well for the future.

It will also be in the grateful recollection of not a few that the farmers of this county had for many years the counsel, the kind co-operation, and the living example of the late John Foster, Esq., of Brickhills. He was long the connecting link between the landed proprietors and the yeomen of the county, and a most welcome guest at all their agricultural gatherings. Those noblemen of the last generation, to whom reference has been made, have not merely created a spirit of enterprise among the present race of farmers: their example has been equally beneficial to the nobility and gentry of the county in the present day. For, while it may be questioned whether any county, with few exceptions, is now better tenanted, it is equally true that it contains a goodly array of first-class "live and let live" landlords. One proof may suffice among the many that might be adduced, and which must be patent to all: so changed are the views of many of the landlords of the county as to the propriety of preserving an enormous quantity of game, that committals under the Game Laws are now little more than as one to ten compared with those of thirty or forty years ago. This is a fact not to be lightly estimated, for, coupled with the improvement in the Poor Laws, nothing perhaps has tended more to inculcate provident habits and to raise the tone of morals among the labouring classes.

II.—*Lois Weedon Husbandry.* By the Rev. S. Smith.

I am deeply indebted to Mr. Lawes for his paper in this Journal "On the Growth of Wheat by the Lois Weedon System on the Rothamsted Soil."

The design of the paper is admirable. For, great things are promised to him who farms upon the system under review,—even a large profit, with wheat at 40*s*., or as low as 35*s*. a quarter: and it was right that care should be taken by some competent person that in such a matter no one be misled.

But, not only is the wheat crop to be thus profitable: it is to be grown year after year without manure on the same acre or acres of land, as the case may be. So that if a man, farming after this fashion, have 300 acres of ploughed land, and keep the self-same 100 acres continuously in wheat, he has only two-thirds of his farm to manure.

For eleven years this plan of growing wheat has been in successful operation at Lois Weedon,—with an excellent promise for crop number twelve; and before I notice the Rothamsted experiment it may be well to examine the cause of this success.

1. The land at Lois Weedon devoted to wheat, is wheat land; one piece being wheat land naturally, the other being made so by marling. The mineral food for the wheat plant is thus secured, existing as it does in land of this quality and condition.

2. But, as a sufficiency of this mineral food might not be in a prepared state for assimilation without exposure to the solvents of the atmosphere, a portion of the subsoil, as it is required, is brought to the surface to have a winter and summer fallow.

3. To secure this annual fallow, without the loss of the annual crop of wheat from the same acre of land, the crop is grown in strips of three rows of wheat (or of two, as the case may demand), a foot from row to row; a fallow interval of 3 feet running between each triple or double row; the strip of one year's wheat being the fallow for the next, and so on alternately from year to year. This fallow interval is limited to 3 feet; because, with more, the bulk of the produce of wheat would be greatly diminished; with less, it could not be worked.

4. The bringing up of the subsoil of the intervals, however, is not enough: the conditions of the system are,—that this exposed subsoil be literally pulverized,—actually broken to atoms and brought down to dust, and then mixed with the pulverized staple.

A few moments' consideration will show that this is at the root of the system,—is its very life,—without which it dies. It is, in fact, in the stead of manure. It may be said to *create* a certain portion of the nourishment of the wheat crop; for, the undersoil

being thus thrown open to the action of the atmosphere, fresh supplies of mineral food are constantly being liberated and becoming available to the growing plant.

The mineral food being thus provided, and the surface of the soil being always kept open, *the organic elements of fertility*—as many term them—come of themselves. The very process by which I gain the one, admits the other. Carbon and nitrogen are wanted; and the atmosphere contains them both in the forms of carbonic and nitric acid and ammonia. I lay great stress on the contents of the rain-fall. Not for its amount of ammonia and nitric acid alone, for that has been proved, by late experiments, to be insufficient for our wants; but, for the proof which is thus gained, by easy analysis, that these substances do exist in the air. Besides the rain there is the snow, which holds ammonia and nitric acid in quantities comparatively very large. And, as regards the dews and fogs, they are declared to bestow on the earth the richest treasures the atmosphere contains. With every shower of rain, then, with every descent of the dew, every fall of snow,—nay, with every breath of interpenetrating air, these organic substances are brought down into the porous soil, either for future use, or to be taken up at once by the unconfined rootlets of the growing plant. They are brought down, I say, into the *porous* soil; for, if it be not made porous, and kept so,—if the surface become crusted over, the treasures of the dropping atmosphere still fall on it, indeed, but only to be quickly exhaled again; while the air, with its genial and untold influences for good, passes over its closed bosom altogether and is gone.

I confine myself strictly to the fallow and crop system under discussion, when I say that this atmospheric supply of nitrogen abundantly meets the wants of my wheat crop; so that, commencing with a year's fallow, I require beyond this no more natural or extraneous provision of this substance within the soil. Nay, I have found that over-feeding the plant with nitrogenous food is positively injurious. No report having yet been given of my wheat crop for 1856, which was the eleventh unmanured crop on the clay piece, I will, in order to illustrate my position, refer to it here. To increase the extent of my wheat four years ago, a strip, rich with the remains of former dressings for roots, was added to the original plot; and every year that strip, in a marked manner, has yielded the worst wheat; so much so that even this last year's crop, as a whole, was somewhat damaged by it in sample. The yield was upwards of 37 bushels to the (half) acre, of good, saleable Lammas wheat; and had it not been for the thinner grains of the over-fed portion, the yield would have been greater altogether, and the sample perfect. The produce of

tall bright straw amounted to the remarkable weight of two tons to the (half) acre.

The sixth unmanured crop on the light gravel land, which has twice yielded 5 quarters to the (half) acre, gave last year (with its two rows instead of three,—a diminution of rows causing the comparative loss of one-sixth of the produce) 30 bushels of superior wheat, with bright clean straw. And there, too, four years ago, a small strip, manured for roots and unexhausted, was added to the original piece; the fresh strip always tending to over-luxuriance and mildew, which tendency, I conceive, it will never lose till the surplus nitrogen within the soil be reduced.

Such are the leading points of this plan of growing wheat; and I now come to the trial of it at Rothamsted.

At Lois Weedon the success of the plan has been signal, unfailing, and undisputed. "And yet," says Mr. Lawes, "it is somewhat singular that those who have endeavoured to follow the directions given, on other soils, have generally been unsuccessful."

I am perfectly aware of these reported failures; but no one hitherto has come forward by name and published the details of his unsuccessful efforts. So that there has been nothing tangible,—no case that could in reality be met. Therefore it is that I am so indebted to Mr. Lawes for his paper. He steps boldly forth and says, "I have tried the plan, and it has signally failed. I have tried it for four successive years, and each year the produce has been miserably poor and blighted. Here, in the paper I lay before the public, is Mr. Smith's plan as I have carried it out; and here I think it right, in the Journal of the Royal Agricultural Society of England, to show to the agricultural world, that the plan has little chance of succeeding on any soil but that at Lois Weedon. For it so happens that the Rothamsted soil is peculiarly suited to test the fact: it has a staple of loam, a stiff clay subsoil, with chalk at a great depth below; so that it may be well taken as a type of all other wheat land; and as it did not answer here, it cannot be expected—with the single exception I have admitted—to answer anywhere else."

Such, in effect, is the point aimed at by Mr. Lawes in this report of his experiment; and my reply to it shall be brief and out-spoken.

If Mr. Lawes had really carried out the plan, and found by unmistakeable signs that, notwithstanding a proved abundance of mineral food, his wheat-crops failed year after year for want of available nitrogen, I could have understood and valued the well-intentioned experiment. Or, if he had erred in the execution of

some minor detail, it might have been overlooked. But, I am compelled to say, that in every essential point the conditions of the plan have been so utterly disregarded as to vitiate the experiment altogether.

To come at once to the proof. In order to provide a sufficiency of available nitrogen to feed the wheat-crop, it is in the rules, it is the leading principle of the plan, it is indispensable, that the land be pulverized and its surface kept open. And yet, what does Mr. Lawes, in the paper before us, own? He owns that his trial-piece was not pulverized, or its surface kept open; but, on the contrary, that it became foul and crusted over during summer. Notwithstanding this avowal, by a singular process in logic, he would by implication condemn the plan because the want of available nitrogen was one great cause of his failure.

But, he has a reason for not pulverizing his land. He employed, he says, the same means as those in use at Lois Weedon, but "they were insufficient for the soil at Rothamsted." He does not pretend to say, what no one could say, that his land was incapable of being pulverized, for judicious tillage is able to render "the harsh and most uncivil clay obsequious to the husbandman;" but that, using the same mechanical means, he could not attain the same end.

Did he use the same means? I have by me the first edition of the 'Word in Season to the Farmer,' published in 1849; and also the ninth edition, published in 1852, containing the directions before published in 1851. Mr. Lawes having entered on his experiment in 1851, we will for his first crop refer only to the edition of 1849 for the rules then laid down for pulverizing the soil. Describing the digging of the intervals for my fifth crop of wheat, I speak, in p. 5, of its being "two spits deep; and after the pan is a little moved, the staple is turned upon it, and the second spit is gently laid uppermost, in such a form that the frost may be felt right through the whole." "The winter fallow over, I give my spring stirring with the fork, which moves, without damaging, the spreading fibres; and *I follow up that with the horse-hoe as often as the surface incrustates, and as long as the growing corn will permit.*"

These were the means in operation at Lois Weedon from the very beginning. Did Mr. Lawes, in this turning point of the system, scrupulously carry them out?

The winter fallow over, he gave the spring stirring with the fork; and after that, as long as the growing corn would permit, what followed? Two scratchings with the hand-hoe, and no horse-hoeing whatever—a very costly method of evading the rule and defeating the plan; for, for the expense of even one hand-

hoeing to do the work ill, he could have horse-hoed six times and done it well.

Or, if I have misunderstood Mr. Lawes, and the two hand-hoeings were only for the wheat rows and not for the intervals, the case against him is stronger still; for then there was not even any hand-hoeing of the intervals at all; and only an occasional spudding is to be set against my deep horse-hoeing, "as often as the surface incrustates and as long as the growing corn will permit."

There are two ways, however, of defeating a rule. By coming short of it, and by going beyond it. "It is certain," says Mr. Lawes, "that the same amount of labour expended upon the Rothamsted soil as upon the Lois Weedon one, was quite inefficient to get the same amount of staple, and of exposure of surface to atmospheric influences." I have shown how Mr. Lawes broke the rule by coming short of it,—by not tilling his land as I have tilled mine, or expending upon it the same amount of labour. I have only one thing more to do, and that is to show how fatally he erred by going beyond the rule and defeating it thus.

To explain in what way this error was committed I must go back for a moment to the first proceedings in this career of double-digging for the wheat-crop. In preparation for the plan, the land, after a winter fallow, is to be ploughed and harrowed and rolled; and harrowed and rolled and stirred again, *as for barley*. This thoroughly pulverizes the 5-inch staple. In the second week in September the seed is in, and in a month is up. Then, when the lines of wheat are well marked, comes the digging of the intervals. With regard to the depth, the principle from the beginning was,—to bring up just so much of the subsoil as could be pulverized and mellowed during the annual fallow; and the published rule in 1851 was "4 inches" if the soil be tenacious; this warning being added in italics, that "To bring up more at the outset would be *a wasteful and injurious expense.*"

By the 4 inches fixed on for tenacious soil, such as that at Rothamsted and Lois Weedon, the intelligent farmer, having caught the principle, would understand that there was nothing magical in this precise number 4; but that if a depth of 3 inches, or even 2, in his unusually stiff soil, would better come down to dust than 4, he would confine himself to that, and be satisfied; for he would recollect that if he brought up only 2 inches, he would still, from the moiety of his acre, get 100 tons of fresh virgin soil.

In digging the intervals of clay land, then, at the outset, I cast the 5 inches of well-pulverized staple to the bottom, and place on the top the 4 inches of tenacious clay, making altogether 9 inches to dig, either at two very shallow spits, or at one ordinary

spit; only 4 inches being fresh ground for the fork. For this first operation the expense is moderate; but as the charge increases for the stubble land and for the gradually increasing, but partly pulverized, depth, I find the average payment, after a series of years, when enough fresh ground has been broken and I go back again for a few years to the depth of a single spit, to be 1*l.* 10*s.* or 1*l.* 14*s.*—which latter amount includes the throwing out of the stones and the weeds.

Did Mr. Lawes adopt this method of digging; or did he defeat the rule by going beyond it? Let him speak for himself. "The fallow intervals which were not sown [were] trenched 14 to 15 inches in December, 1851, forked in spring and again before sowing; occasionally spudded, but became foul and crusted over during summer." At the very outset (that is, in preparation for the second year's crop), and all through the trial, during which there were only three double diggings to receive the seed, the trenching was 14 to 15 inches deep, a spit of the raw clay subsoil, for two out of the three diggings, being placed on the top, and the half-tilled staple below.

In thus going beyond the rule and digging too deep, Mr. Lawes did indeed incur "a wasteful and injurious expense." For, instead of the average payment at Lois Weedon, the trenching at Rothamsted cost him, he says, "on the average about *once and a half as much* as is estimated by Mr. Smith." And so injurious was this wasteful expenditure in doing wrong, that, in comparison, all minor errors of execution sink into insignificance. For, of all conditions of soil, there is none which the wheat-plant so loathes and sickens almost to death in, as this deep and hollow aggregation of unmellowed clods.

I will not stop, then, to ask, why, in opposition to the rule, 4 feet intervals were used by Mr. Lawes, instead of 3, to the evident diminution of one-sixth of the produce; or why, being used, my licence is quoted, since the licence given is wholly inapplicable. Nor will I dwell on the omission of the safe roller after sowing and in spring; or, in defiance of the rule, of the sowing twice out of the four times so late as October, at which time, according to the provision made in the directions for exceptional cases, the seed should have been sown "for a thicker crop." Nor need I, I am sure, apologize to Dr. Gilbert for passing by, without notice, the laborious calculations and analyses of his laboratory; for, he is too sensible not to see that, where the premises of an argument are proved to be unsound, no conclusions, however ingenious, have the slightest interest or value.

I am anxious to disencumber the question of everything in the way of a clear understanding of the real point at issue. The question volunteered by Mr. Lawes is—Can the Lois Weedon

plan of growing wheat be carried out with success at Rothamsted? And his answer, after a trial of four years, is, that with the same amount of labour and the same mechanical means as those employed at Lois Weedon, it cannot. It has been for me to show, from his own statement in this public Journal, that the same amount of labour and the same mechanical means have not been employed; that the great principle has been violated; and that the result, in consequence, has been, *crops poor in amount, foul in growth, and in quality blighted and bad.*

Had the conditions been fulfilled, the thin sowing, at a peck to the acre, might have succeeded with a high average produce, as it did for years at Lois Weedon, where the very first crop on the light land, after wheat, yielded 41 bushels of excellent grain, though large and somewhat coarse. It would have produced, as it did there, fine bold ears of an extraordinary size, with thick reed-like straw. It is nothing to the point, then, that, for better security against losing plant, I now sow two pecks instead of one, the smaller grain making a more marketable sample, and the finer straw being more useful at home. It is enough that the one peck succeeded at Lois Weedon, being sown in due time on land properly tilled and pulverised, and yet well solidified with the roller at seed-time and in spring; while it was certain to fail—as any amount of seed would have failed—on a spit of what was little better than raw, unmitigated, unpulverised clay. The trial-piece at Rothamsted being in this condition, I will only add, in conclusion, that I do not believe there is a farmer in England, acquainted with his business, who will not share my surprise, not that the crops were so bad, but that there were any crops at all.

Lois Weedon Vicarage, May, 1857.

III.—*On the comparative Advantages of sowing Beans in Spring and Autumn.* By Robert Vallentine.

Prize Essay.

The comparative advantages of sowing spring or winter beans are not very numerous, but still not unimportant. It is, we imagine, generally known that winter beans cannot be sown in spring to ensure any chance of a *good* crop, nor can spring beans of the usual kind be sown in winter with the least chance of becoming a crop at all.

Winter beans, to me, certainly possess some obvious advantages over spring ones; the chief of which are that they are less subject to blight and other diseases than spring beans:

and also that they may be sown in autumn when the state of the land and the labour of the farm will permit, and thus curtail the labour of spring—which is always a busy period—so as to apply the strength of the farm in preparing for other kinds of corn, &c.

As I am writing from practical experience and observation extending over a period of fifteen years, I do not care to enter into a philosophical discussion regarding the habits of plants, nor to dilate on *insectology*. All that I aim at is to state *results* and leave *causes* pretty much alone. I may, therefore, say that I never saw winter beans much damaged by blight or any other disease, but have frequently seen spring beans almost entirely destroyed by various kinds of insects about the time of blossoming; so much so, that the land has been ploughed up and sown with some other green crop. I never knew a case of winter beans failing so signally in summer as to lead us to adopt such a sacrifice; and, therefore, winter beans have a decided advantage over spring beans on the score of disease. Winter beans have frequently failed in spring, however, when sown too late in autumn, or when sown on wet undrained clay in severe winters. Late sowing should, therefore, be avoided, and so also should wet land. The severity of winter cannot, it is true, by any means be avoided, but its consequences may be rendered harmless, as far as regards beans, by attending to draining and early sowing. If beans are sown early, say at the end of September, or beginning of October, they will soon come up out of the reach of vermin, and be enabled to take a good, deep, and wide-spreadhold of the soil, which no winter we have ever seen was severe enough to destroy. Indeed, we have had winter beans so far above ground in October, as to be in an excellent state for hoeing; and when this was done in dry weather, the cultivation required in spring was very light. When beans are sown early the vegetation above ground is almost entirely destroyed by a severe winter, but in spring a second growth takes place, and continues till harvest, which is usually at the *commencement* of wheat harvest, whereas spring beans *follow* wheat, and are a month later than winter beans; that is also a recommendation of winter beans which should not be overlooked. The disadvantages of winter beans are alleged to be failure in severe winters, and a less yield than spring beans. On very retentive clay soils spring beans should have the preference, to obviate any chance of failure by severe frosts; but I certainly never saw a single instance of failure occur from severe weather but what might be traced to the predisposing causes of late sowing, and sowing on very wet land. The yield of spring beans has been occasionally higher than any crop of winter beans we know of: but the yield of winter beans is more *uniform*, as

might be inferred from their less liability to premature ripening and disease. We have known winter beans to produce 7 quarters per acre, and as little as 32 bushels per acre, all grown on good land in very high condition. Spring beans sometimes reach 8 quarters per acre, and some seasons do not exceed as many bushels.

We have endeavoured to show that winter beans possess some advantages over spring beans on the head of disease, and also that when sowing in autumn takes place the labour of the farm is forwarded, which is of great importance of itself. It so happens, however, that farms of suitable soil for beans are also suitable for wheat, and that the proper time for ploughing and sowing wheat is also best for beans. Thus, wheat-sowing is attended to first, and when that is finished it is generally too late to sow beans in season, so that, if sown, disappointment follows, and winter beans are condemned without just reason. When winter beans were introduced into this country about thirty years ago, and when partially grown subsequently, there was scarcely a failure, owing, we think, to more care being used in sowing at the proper time and under suitable circumstances; but of late partial failures have been common enough, which in a great measure may be attributed to want of proper management. Winter beans are certainly not so much sown now as they were a dozen years ago, in those districts with which I am acquainted, for the reasons assigned, and also that where beans hold a constant place in a rotation with wheat, it is seldom that horse-labour can be spared in autumn for ploughing for beans as early as necessary. For spring beans the land can be ploughed any time in winter so as not to interrupt other kinds of work; and the mere drilling and harrowing bean-land in February or March does not interfere with ploughing for and sowing barley or oats, neither in the preparation for root-crops. It should always be the aim of every arable farmer to keep a sufficient number of horses to accomplish his work in due season, but not more. In order, therefore, to keep as few as necessary, the labour of the farm should be so distributed over the whole year as to provide nearly constant employment, without standing still at one time and at another having too much in hand to do it well. It is, we think, for these and similar reasons that spring beans are so generally sown instead of winter beans. Because, if there is a sufficient strength of horses on a farm to plough and sow both for wheat and beans in autumn in proper season, there would be an expensive surplus during winter, which in all ordinary cases could not be profitably employed. It is very rarely the case that wheat-sowing can be finished by the middle of October with all the strength of the farm applied to it. It is then a chance only whether the plough-

ing and sowing of winter beans can be accomplished in due season.

There are, however, exceptional cases when land may be ploughed for beans during harvest, or immediately after it, when ploughing for wheat cannot be carried on properly. It is then that the sowing of winter beans instead of spring beans should take place with everything in its favour.

Common winter beans are said to be of both Russian and French origin. Whatever the origin or original distinctions may have been, there is no particular difference known now amongst farmers. Winter beans are very small, of a darker brown colour than spring beans, with a very black eye. They usually weigh, when well harvested, from 63 lbs. to 66 lbs. per bushel, and about 6 grains each. Common horse-beans, sown in spring, usually weigh from 62 lbs. to 64 lbs. per bushel, and about 14 grains each. There are many varieties of tick-beans, or at least many tick-beans sown of different names, which are much alike in appearance and habits of growth and yield. The Harrow tick and French tick are both small seeds, and usually weigh from 63 lbs. to 67 lbs. per bushel. The horse-bean and mazagan are most commonly sown in England, as they yield more straw and corn than the ticks. Ticks are better adapted for comparatively light soils than the common horse-bean, and as they seldom run much to straw are very suitable for allowing a thorough cleaning by the horse and hand hoe throughout the summer. Some seasons we have seen tick-beans produce so little straw and leaf as to allow of horse-hoeing nearly up to harvest without injury to the crop. The land was thus kept free of all annuals, and spots of couch were easily destroyed by being repeatedly moved; yet, although the crop in growing looked small, the yield at harvest has reached 40 bushels an acre, and in one instance, where the straw was only 30 inches high, the yield was 50 bushels an acre. Beans, however, which produce little straw allow more annuals to grow, unless well hoed, than such as produce much straw, which covers all the ground and in a measure smothers the weak under-weeds.

There are very few farmers who would acknowledge any system of growing corn which would *encourage* the growth of weeds rather than destroy them; but, whether acknowledged or not, it is true that in too many instances a bean crop is anything but a cleansing one, and more generally leaves the land fouler when the crop is reaped than when sown.

To obviate this evil the cultivation of beans, whether sown in winter or spring, must be such as to allow of horse cultivation; and to accomplish this the seed must be drilled or planted in straight lines, with a sufficient width between the rows to admit

of horse-hoeing and a free course of hand-hoeing in all directions. When land is of a very adhesive nature, and contains a good deal of *couch*, the only chance of getting it cleaned in summer is to ridge it up in winter, in rows from 24 to 28 inches apart. The winter's frost will then so loosen it, that in the spring the ridges should be divided, new ones formed, and the beans be either drilled or dibbled on the top. By this system the horse-hoe can be set early to work between the rows without injuring the beans, and may be kept at work late also: and, in addition, hand-hoeing and picking off the couch will, if well followed up, entirely clear the land of weeds, and permit of a good crop growing also. The cultivation of beans by such method is the same as for roots grown on ridges; and without ridges foul land *cannot* be cleaned at the time that a crop of corn is growing upon it.

In ordinary cases, when land is free, or nearly so, from couch, the cultivation of beans upon the flat surface is most usual and answers very well. The rows should never be less than from 18 to 24 inches apart to allow the horse-hoe to work freely between them without smothering the plants. The common horse-hoe used for turnips does well in general, and if the ground get very hard a plough divested of the turnfurrow and coulter should be used. The left-hand side should go as near the plants as possible, so as not to interfere much with the roots or smother the plants; and if a turn of the plough is thus given between every two rows, the soil is so loosened and broken up that many weeds are killed in fine weather by this operation, which also allows of ready hand-hoeing afterwards on the surface, and the spreading of the roots when horse cultivation is suspended. Beans can be dibbled in straight lines by hand equally true as by the drill, however long the length may be. We have had them dibbled by hand in lines nearly 20 chains long without any apparent deviation from a straight line.

Beans cannot be properly drilled on newly broken-up grass-land. The coulters become choked and cannot go deep enough to deposit the seed. Neither does the drill work well on land when very stiff or when pieces of dung and bunches of stubble lie about the surface. Dibbling is then preferable. The seed should be put in from 2 to 3 inches deep—the deeper the better in general. The quantity of seed used for both winter and spring beans ranges from 3 to 4 bushels per acre. 3 bushels should in general be sufficient, but on poor land in rough condition 4 bushels are not too much. A two-horse drill should get over 8 acres a day. A horse-hoe should get over 3 acres a day if the rows are about 2 feet apart. A man can dibble from one-third to one-half an acre a day. I give 6*s.* per acre for dibbling

in straight rows from side to side of the field, the rows being 18 inches apart. Many persons still dibble beans at a certain sum per bushel. This I consider to be an evil practice, as both encouraging laziness, theft, and irregular seeding. When a man gets a bushel of beans to plant in a day, if he have any tendency to bad habits about him, he will either sow the seed too thick, throw some of it into a ditch, or steal some to get rid of it.

Planting by the acre, and allowing a stated quantity, appears to be as near a correct system as can be attained when sowing by hand is necessary.

Beans have long been chiefly confined to the stiffest description of clay soils, and are now in some cases superseded by root-crops, but we think it will be a very long time before root-crops become general instead of pulse; and as beans are a substitute for roots, and are regarded as a cleansing crop, it is desirable that it should be so, and that those who cling to drilling and dibbling in narrow crooked rows, and hand-hoeing only, should adopt a more enlightened and economical course.

To sum up—we would sow beans in autumn rather than in spring, when the labour of the farm would admit of its being properly done before the end of October. Spring beans should be sown in February, or not later than the middle of March. All kinds of beans should be put into the ground from 2 to 3 inches deep, and always in *straight rows* from 16 to 28 inches apart to admit of horse cultivation. Hoeing should take place early, and as frequently as is required to thoroughly clean the land and encourage the growth of the crop. We feel assured that the frequent stirring of the soil has a great tendency to prevent disease, and is a source of ultimate gain in every case, when done with ordinary discretion.

Burcott Lodge, February, 1857.

IV.—*Observations on the Natural History and Economy of various Insects, Snails, Slugs, &c., affecting the Clover-crops and Pasture-lands.* By JOHN CURTIS, F.L.S., &c.

PAPER XVI.

HAVING in my former Reports detailed the history and economy of the various insects injurious to turnips, corn-crops, mangel-wurzel, peas, beans, carrots, potatoes, &c., as well as those destroying corn in granaries, it now only remains for me to make known to the agriculturist the legions of insects which ravage his clover and other similar crops, his artificial grasses, and pasture-lands.

These crops are the nurseries of those myriads of flies, gnats, beetles, &c., which disperse, and, settling in the fields, carry with them blight and destruction.

Thus the daddy-long-legs luxuriates in pastures, and visits the mangel-wurzel; the *Chlorops* and *Oscinis* (little flies) have their head-quarters in the central shoot or flower-stem of grasses, attacking our autumn-sown corn-crops in the end of winter; a weevil (*Curculio lineatus*) is propagated in clover-fields, but renders pea and bean fields unproductive by its migrations; and the wireworm finds a permanent asylum in damp pastures.

These are facts well deserving the attention of the farmer; and as some insects cannot exist without humidity, because their transformations are arrested, and the larva dies, or the pupa is unable to produce the fly; so other species only multiply in dry seasons and sandy situations. Moreover, as we know that salt, soda, ammonia, gas-tar, soot, and lime, are destructive to insect life, the farmer could not do a greater service to agriculture than by trying experiments with these substances upon the various pests which may fall under his notice. But unless he records the facts, and sends them, however trifling they may appear to be, to some of our journals connected with agriculture, no beneficial results can be expected. It is only by the united labours and experience of the many that scientific men can draw conclusions on a subject which, like chemistry, has so much concealed from him. A farmer in his field, or a gardener in his garden, may chance to light on a fact in the economy of an insect which the naturalist may have been searching for in vain for years, and it may enable him to comprehend what had hitherto been to him a puzzle or a mystery, and to draw conclusions from it of great practical importance.

Clover.

The amount of injury which clover crops suffer from the inroads of insects cannot be estimated. The farmer finds his crop thin, the leaves riddled; and this is the work of a weevil which will pay a visit eventually to his pea and bean fields.* His seeds fail, not yielding a tithe of the full amount. Let him spread a white napkin in the field, and shake and beat the clover-heads, and he will find the destroyer in myriads, probably in the shape of a little black weevil with a long pointed nose. There are also various caterpillars feeding on the foliage which are less destructive, because they are less numerous, from their being kept under, in all probability, by parasitic flies. It will now be

* *Vide* Journal of Roy. Agr. Soc., vol. vii. p. 408, pl. Q. f. 1, 2.

my purpose to describe these insects, detail their economy, and suggest remedies against their invasions.

1. CURCULIO (or SITONA) LINEATA (*Linn.*)

having been described and figured in a previous report, I need only refer to it to identify this pest; but as at that time I was not fully aware of its extensive presence in clover-leys, this portion of its history will be useful and instructive.

It is a remarkable fact, that, abundant as this insect is, and a species well known to Linnæus and men of science for more than a century, we are still ignorant of its entire economy. No one knows where the female lays her eggs; no one knows where the maggots feed, or where they change to *pupæ*. I imagine the eggs are deposited in the earth, and that, when hatched, the *larvæ* feed on the roots of the clover; but this remains to be proved, and it would be a most valuable discovery, well worthy the attention of those who find it in abundance on their crops.

These weevils, which sometimes swarm to an extraordinary amount in clover-fields, completely riddle the leaves, reducing them to skeletons. We need not recapitulate the facts which were communicated by Mr. Trenchard and Mr. C. Parsons, and recorded by us in our report on the pea-crops in the volume just referred to. It may, however, be stated that nothing regarding their transformations has been since discovered, and consequently no remedies can be suggested for their extirpation beyond those already recommended in that report.

Whilst the *Curculio lineatus* confines itself to the destruction of the foliage of the clover, there is a family of minute beetles or weevils, called *Apions*, which not only devour the leaves, but destroy the seeds also. They are pear-shaped, black or bluish, having a long rostrum or beak, at the extremity of which is placed the mouth. They are very active, running about and falling down on the approach of any one, and they are furnished with ample wings* for flight. The first of these little pests is named

2. APION APRICANS, *Herbst*; A. flavifemoratum, *Kirby* (Pl. W., fig. 7; 8 magnified); or the Purple-clover Weevil.

It is shining, bluish-black, pear-shaped, the body being oval and tapering from the thorax, so that the head is elongated into a slender proboscis, which forms, as it might be termed, the stalk of the pear. At the extremity of this beak is placed the minute mouth, which is composed of two horny *mandibles* or jaws

* Mr. Markwick was mistaken in supposing *Apion flavifemoratum* had no wings; for they are twice as long as the wing-cases in both sexes.

(fig. 9); they are convex externally, terminating in three teeth, and meeting in front when closed; below these are placed two *maxillæ* (fig. 10), broad and flattened, each forming a ciliated lobe in the inside; just behind this is inserted a very short three-jointed *palpus* or feeler; between these *maxillæ* is placed the horny *mentum* or chin, from which arises a membranous pubescent lip, the *palpi* or feelers being very indistinct (fig. 11). The head and trunk are punctured; the former is channelled between the eyes, and the latter has a channel down the hinder part: the body is covered by two wing-cases, on which are sixteen punctured furrows, and beneath these are folded and concealed the two ample membranous wings. It has two eyes near the base of the head, and the pair of eleven-jointed horns are placed on each side of the trunk, and near the middle; they terminate in a little oval club; the first joint is the largest, and is bright ochreous, and sometimes the second and third also: the six legs are of the same bright ochreous colour, the tips of the thighs being black, as well as the shanks (excepting the first pair), and all the feet: the *tarsi* or feet are composed of four joints, the third being bilobed, the fourth club-shaped and terminated by two minute curved acute claws. The *male* is rather smaller than the *female*, with a shorter and stouter *rostrum*.

These little beetles are probably in greatest abundance when the clover is in flower, at which period the female deposits her eggs. This may be easily ascertained by the numbers which are pairing about that time. My observations on their economy have been principally made in the months of August, September, October, and November. On examining the heads of the purple or honeysuckle clover at the end of August and the beginning of the following month, when the clover was in flower and many of the heads appeared blighted, I found three or four little fat white maggots, with brown heads, curled up at the base of the calyces (fig. 1). The *larvæ*, or maggots, were eating the seed from the outside of the calyx, through a hole which they had first made (fig. 2). They change to *pupæ* in the same situation, and when the beetles hatch the females proceed, after impregnation, to a fresh head of flowers, to deposit their eggs. In the middle of the following November I again examined the clover-heads, and found two larvæ, like little *Melolonthidæ*, with six distinct pectoral legs (fig. 3; 4 magnified). The *pupa* is of an ovate form, tender, whitish, with dark eyes, and through the thin skin may be traced the form of the proboscis, which is bent down on the breast, below which the legs are folded (fig. 5; 6 magnified). In this state it generally remains about twelve days, or it may be till the following spring. When the beetles are first hatched they are very soft and tender, and I have observed that

the wing-cases are then of a grey colour, but they soon assume their proper tint.

I doubt not that these weevils are annually produced in great numbers, for they are common everywhere. I may mention, however, that they were particularly abundant in Surrey and Suffolk in 1840 and 1841, and they were in profusion in the clover-fields in Middlesex. Some idea may be formed of the ravages occasioned by this weevil from the following communication made to me in September, 1844, by Mr. Wm. Trenchard of Sherborne:—

"I have a field of clover which has been twice mown, and there is now a fine aftermath. The part of the field near the stack has been lately attacked by a small black weevil, which advances in a semicircle, totally destroying every leaf, leaving only the fibre. I should think there are on some of the leaves as many as 100 or 150. Since last night they have eaten nearly as much as would have kept a sheep. In September they seemed to have been somewhat weakened by the late heavy rains. They destroy every leaf in their progress."

When one sees in a field of clover, which is in flower, patches of discoloured or brownish heads which appear to be withered, it is a certain indication of the presence of these weevils.

This destructive weevil is no new pest, for its economy was known to Linnæus, and was verified by Mr. Markwick as long back as the year 1800; and in 1801 the latter communicated his observations to the Linnæan Society.* In Mr. Markwick's case the *larvæ* were in full force in the beginning of August, and changed to *pupæ* in the middle of the same month; and at the same time the weevils were hatching. The damage done at this time is accurately shown by figures, for he states that in

"1798 I grew on 9 acres of ground (just double the quantity that was saved for seed this year) either 33 or 34½ bushels of clover-seed, of which 28½ bushels were sold for 50s. per bushel, and the rest, amounting to either 5 or 6 bushels (I am not quite certain which) was kept for my own use; so that, taking it at the lowest, the statement will stand thus:—

	Bushels.	£.	s.	d.
In 1798 four acres and a half, being half of the crop ..	produced 16¾, which sold for ..	41	17	6
This year (1800) the same quantity of ground produced only	,, 7½, worth at same price	18	15	0
Deficient	9¼ .. .. worth	£23	2	6

Thus it appears that the loss on this year's crop is very great, occasioned, most probably, by the depredations of this insect; and besides, what seed I have is of an inferior quality."

In 1843 a valuable pamphlet upon the insects injurious to agriculture was published by M. Guérin Méneville,† in which

* Trans. Linn. Soc., vol. vi. p. 142.

† Extrait des Mémoires de la Société Royale et Centrale d'Agriculture, année 1842.

were given some excellent observations upon the economy of this insect by M. Herpin, a translation of which I shall introduce here without further apology :—

"The standing crops of the cultivated clover (*Trifolium pratense*, Linn.) are attacked by a larva of the family of Curculionidæ, which establishes itself in the flowers of that plant, and which, after having pierced the calyx and envelope of the young seed, gnaws and destroys the interior substance as fructification progressively advances. On entering a field of clover while it is in full flower, one perceives, without difficulty, a considerable number of heads, of which the brown and withered corollas and the blackened calyces show that they have long since done flowering.

"On attentively examining some of the full-flowered clover-heads, it will be observed that, among the large quantity of florets composing these heads, many of the florets have already passed the time of flowering; they are brown and withered.

"This premature and partial maturity of the flowers is commonly a characteristic sign of the presence of the larva of the *Apion* we are speaking of.

"In truth, if we spread open, or carefully pull out, some of these withered flowers, we shall perceive, near the base of the calyx, that is, near the point of its junction to the stalk, a small black spot, or little hole, similar to that made by a fine pin; on slightly compressing the calyx, we shall see come forth from this little hole a white, soft larva, rolled up, 1 or 2 millimètres in length.

"When this larva has arrived at its full growth, it forms, outside the hole which it has perforated in the calyx, a globular white projection (at most 1 millimètre in diameter), which might be taken, at first sight, for a grain of powder or plaster.

"This larva afterwards changes to a nymph or chrysalis; it remains in this form for about 12 days. Towards the end of that period, one sees that the nymph, which was originally of an ivory-white, is sprinkled with blackish points; the form of the rostrum, the eyes, and the legs of the insect are very distinctly indicated under the envelope which covers them; the rostrum occasionally makes slight movements.

"From this *nymph* comes forth the little *Apion apricans*, which has long been known to naturalists, who find it upon walls and in fields.

"My clover was mown in full flower, then dried, although with some trouble on account of the bad weather, and came again into leaf as usual. What could become of the numerous larvæ housed with the clover? They were probably suffocated by the heat, or stifled by the escape of carbonic gas produced by fermentation and the stacking of the plant.

"Ten or twelve days had scarcely elapsed after the housing of the clover in the granary, when I perceived a great quantity of apions moving in all directions upon the walls of the building, and making their way towards the outside. The escape of these apions went on for eight or ten days.

"Although the quantity of these little insects which escaped from the granaries was innumerable (for the walls were covered with them), I could not find a single one at some distance in the country, or even in the nearest plots of clover. However, as these insects, as well as their congeners, shun the daylight and conceal themselves, they might easily escape my investigations through their extreme minuteness and deep green colour.

"But it was a matter of the greatest interest to know whether the second crop of clover which sprung up would be also infested by the apion. I searched with a great deal of attention, and I eventually perceived that the ripest heads were in their turn attacked by the same insect, and that finally the second crop was not less injured than the first had been.

"This second crop was mowed, made, dried, and housed in the granary, as was the custom, and after twelve days the little weevils began to hatch and to issue from the granary; soon after I perceived a very great number descend along the walls and make for the outside, as in the case of the first crop.

"Thus then we must conclude, from the facts I have just reported, 1st, That in the space of about 5 to 7 weeks, which is necessary for the growth of the second crop of clover, the pupa of the apion has had time to form itself; 2nd, That the perfect insect has been able to copulate, to transport itself into the fields and deposit its eggs upon the plant; 3rd, That these have been able to develop themselves, and that the larvæ which have proceeded from them have had the requisite time for reaching their full growth, and finally to destroy and devour the seed produced by the second flowering of the clover.

"I obtained only two crops, but it is probable that the third, if there had been one, would not have fared better than the first two. I ought to observe, that my clover had been chalked (*plâtré*) in the spring, and that it was in its second year—that is, it had been sown the preceding year; and that it had not yet been cut.

"I reckon my loss in the seed-crop in 1841, by the clover-weevil, at $\frac{1}{10}$th. The agriculturists also complained, later, that the yield of seed was far from abundant."

There is a species so closely allied to *A. apricans,* that it is believed to be merely a variety. Its habits are the same, and it infests the purple clover; but it seems to be strongly attached to *Trifolium ochroleucum* (the sulphur-trefoil). This little weevil is named

3. Apion Assimile (*Kirby*).

It is rather smaller than *A. apricans*, and is further distinguished by the base of the horns and the fore-shanks being of a duller colour. This weevil is very abundant from the early spring to late in autumn. In April and succeeding months I have found it in abundance in clover-fields, pastures, meadows, and hedge-rows, and in June on the sulphur-trefoil.

The Dutch or white clover (*Trifolium repens*) suffers from the depredations of another allied species of weevil, whose economy has been well ascertained by M. Guérin. This apion is named

4. A. Flavipes, *Fab.*: the Yellow-legged or Dutch-clover Weevil.

It also is similar to the preceding species, but it is still more slender in form, with entirely bright ochreous legs, excepting the tips of the shanks and all the feet, which are intensely black; the two basal joints of the horns are also bright ochreous, and the trunk is not so coarsely punctured as in *A. apricans.* The maggots of this beetle also feed upon the seeds of the Dutch clover. This species is no doubt abundant all the summer, and I have found it in profusion in May on the Dutch clover.

Providentially these weevils are kept in check by various

hymenopterous insects. It appears that M. Guérin bred, either from the larvæ or pupæ of *A. apricans*, the minute fly called by Haliday *Calyptus*, the *Eubazus macrocephalus* of Nees. It is full one line long, of a black shining colour, with transparent wings, a little iridescent, and the base of the shanks is yellow: the female is armed with an oviduct longer than the body, which it can plunge to the bottom of the calyx of the clover, and by means of which it deposits an egg in the body of the larvæ of the apions. This parasite does not seem to be exempt from persecution, for M. Guérin found with the *eubazus* a beautifully-coloured fly, called by Walker *Pteromalus pione*, which is suspected to be parasitic on the *eubazus*.

It would be productive of incalculable benefit if some means could be adopted for the destruction of the apions, as these crops are of such vast importance to the grazier, both cows and sheep feeding on all the trefoils, and clover being such a substantial and excellent food for horses.

We will conclude this important subject with some sensible remarks from M. Herpin's Memoir relative to the destruction of these weevils :—

"Although it be not always in our power to arrest the multiplication of hurtful insects, to destroy them, or to combat them with success, the knowledge of the alterations which they produce upon vegetation is nevertheless very important, since it teaches us to learn the true cause of an evil which may be attributed, but very incorrectly, to vague and inappreciable circumstances, to deleterious conditions of the atmosphere, to divers inexplicable occurrences in vegetation ; it shows us the enemy that we must attack, and of which we must carefully study the habits, economy, and metamorphoses, in order to arrive with more certainty at the means of attaining such knowledge. Nature, as I have before said, undertakes the check of the excessive multiplication of hurtful insects—in the case of the clover-weevil, by exposing it to the attacks of the brood of the *Ichneumon braconide*, which destroys it.

To these natural means, which do not always ensure us against serious losses, I will add the following, which, it appears to me, might be very usefully employed :—

1st. Cut early, and feed off while green, the clover crops which are known, or supposed to be, much infested by the apion.

2nd. Carefully avoid allowing the clover crops to remain more than two years in succession on the same ground.

3rd. Avoid also allowing the clover which is much infested by the weevil to ripen and run to seed.

4th. Alternate and vary the culture, as previously pointed out.

5th, and lastly. We can produce the drying of the clover by the German method, viz. fermentation, by making brown hay (*foin brun*). The alcoholic vapours, the deleterious gases which are formed during the fermentation of clover stacked when green, the high temperature produced in the stack (+60 deg. Cent.,* according to my experiments), suffice to destroy the thousands of larvæ of the apion, which cannot endure so great a heat." †

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* 149° Fahrenheit. † Herpin's Memoir, p. 27.

I must not omit to state that it has been recorded that *Altica nemorum* (the turnip beetle or fly) not only inhabits clover-fields, but feeds upon the leaves.

We will now take a view of the moths which resort to clover-fields in order to deposit their eggs, so that the caterpillars may be nourished on the leaves when the eggs hatch.

These insects belong to the order LEPIDOPTERA, and there is also a beautiful butterfly, which is not abundant every year, but is occasionally not very rare about clover-fields, over which it flies, and deposits its eggs on a trefoil named *Anthyllis vulneraria* (the Kidney-vetch). As this plant does not form an important crop with the English agriculturist, I shall merely observe that the insect alluded to is named

5. PAPILIO (*Colias*) HYALE, *Linn.:* the pale-clouded Yellow Butterfly.

As figures and descriptions of this handsome butterfly are given in the 'British Entomology'* and other works, it is unnecessary to describe it here. It flies in August and September.

There is a large hairy caterpillar which lives on the clover, and produces a fine moth belonging to the FAMILY BOMBYCIDÆ, and to the GENUS LASIOCAMPA; it is named

6. BOMBYX (*Lasiocampa*) TRIFOLII, *Linn.:* the Grass or Clover Eggar Moth.

Head short; eyes small; horns inserted towards the hind part of the head, forming nearly a straight bristle: in the males they are like two beautiful feathers, with a double row of rays; in the females the bristles are merely serrated. It has no tongue or proboscis, as moths generally have, but in front of the head are two small, short, hairy lobes, being the *palpi*, or feelers, which, when denuded of the hair, appear to be triarticulate. The males are always smaller than the females; the trunk is large, not crested. The body of the male is attenuated and cleft at the apex; in the female it is stout and somewhat oval, being generally filled with eggs. The wings are rounded and entire, and when closed are deflected, forming a ridge down the back.

This moth varies greatly in colour, from a rusty grey to a brown tint, and the females are always paler; the superior wings are darkest at the base, with a waved flesh-coloured line towards the hinder margin, and near the centre is a white or cream-coloured spot: the under wings are of a uniform colour; legs hairy, stout; the feet composed of five joints, terminated by distinct claws and

* Fol. and plate 242.

little cushions: expanse of the wings in the male nearly two inches and a half; the female is larger.*

These moths must be sometimes very abundant. They are found distributed over a great portion of the south and west of England. They make their appearance in July and August, and even as late as September. The males are very active, flying rapidly about during the day, being incessantly in search of the sluggish females, which rest concealed amongst the herbage until they are impregnated by the males, when they relieve their dilated bodies of the large mass of eggs with which they are completely filled; and having thus provided for a future generation, the female parent dies.

The eggs are laid singly; they are somewhat globose, smooth, yellowish-grey, mottled with grey. The caterpillars which hatch from them are little black hairy creatures, which change their colour as they cast their skins, and eventually become large, hairy, handsome caterpillars, full three inches long, and as thick as a stout swan's-quill. They have six pectoral, eight abdominal, and two anal feet: they are of a pale smoky or ochre colour; the incisures of the segments spotted with blue. The large eyes appear to cover the head, and the collar is yellowish-red: the spiracles are reddish.

When they are full fed they either spin a loose silken web among the dead leaves or bits of grass and herbage on the surface, or they descend into the earth from one to six inches deep, and there change to pupæ, enclosed in hard, oval cocoons, of a brownish-ochre colour, remaining secure all the winter and spring. The following summer the moth is perfected; it bursts through its shroud, and comes forth to dry and expand its wings—the males making their appearance some days before the other sex, so that they are strong and vigorous before they find their partners. Mr. J. J. Reading, however, informs me that the eggs hatch in March, that the caterpillars feed till the beginning of July, in which month they change to pupæ, and that the moths are produced the latter end of August. These discrepancies in the periods of appearance may be reconciled by the fact that the insects remain sometimes in the pupa state for two years.

If the caterpillars of *L. trifolii* were confined to clover-fields, their ravages would be a very considerable evil, as they are sometimes found in great quantities on limited spots; but few larvæ subsist on such a large variety of food. It has been ascertained that they will feed and thrive upon various grasses, as well as upon the white and red clover, bird's-foot trefoil, the plantain, bramble, the broom, young furze-shoots, and the heath (*Calluna vulgaris*).

* Sepp's Nederl. Insect, vol. ii. p. 51, pl. 13 and 14.

It is recorded by Mr. Reading that they will also feed on oak, beech, ash, poplar, willow, whitethorn, and blackthorn.

A closely-allied moth, named by Borkhausen

7. Bombyx (*Lasiocampa*) Medicaginis (the Medick Eggar Moth),

is in all probability a variety of the foregoing species, the difference of the food affecting the tint and markings of the wings. The *male* is dull chesnut-colour; abdomen brighter; antennæ dull ochreous; eyes ash-coloured; superior wings sparingly speckled with ochreous hairs; an abbreviated and sinuated fascia near the base, and another beyond the middle, slightly toothed on the inside, dull ochreous; a cream-coloured spot near the disk approaching the costal margin; inferior wings rather paler, darkest towards the body, with a curved, pale, rather obscure line across the middle.

The characters that distinguish *L. medicaginis* from *L. trifolii* are the abbreviated fascia next the base of the superior, and the obscure one across the inferior, wings; the breadth of that which is parallel to the posterior margin of the upper wings is also greater.*

The caterpillars of this variety were found in the New Forest in June; they continued to feed on heath, grass, and medick until the beginning of July, when they were full grown and changed to pupæ, from whence they emerged the beginning of the following August.

The eggar moths, like most other *Lepidoptera*, are attended by parasites, one being a minute fly belonging to the order Hymenoptera and the genus Telenomus; but I am unable to give the specific name. It is known to puncture the eggs of the oak eggar moth (*L. quercus*), in each of which the female lays an egg; when this hatches the little maggot there finds sufficient nourishment to bring it to maturity.

A large and handsome species of the family Ichneumonidæ and the genus Peltastes—

8. P. Dentatus (*Fab.*)—is specially attached to *L. trifolii*.†

It is black, deeply and thickly punctured; the horns are long, stout, straight, tapering to both extremities, and are ochreous beneath; nose yellow; thorax with 8 yellow spots before the insertion of the wings, and 2 at the base of the scutellum, which is margined with yellow behind; abdomen elongated, somewhat depressed, and scarcely narrowed at the base, with 4

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* *Vide* Curt. British Entomology, fol. and plate 181, where figures of this moth and caterpillar are given.

† See Curt. Brit. Ent., fol. and pl. 4, for figures and description.

yellow spots on the first and second segments, the remainder margined with yellow. Wings obscure-ferruginous; stigma and nervures brighter. Legs yellow—1st pair the palest; the hinder thighs striped, black inside; length 8 lines; expanse of wings 11 lines. This ichneumon is seen flying in the sunshine in June, in fir groves; it has been taken on the mountains of Westmoreland, and has been bred from the pupa of *L. trifolii.*

There are two very pretty moths which may be seen flying over clover-fields during the day and sporting in the sunshine, like some of the smaller butterflies called "skippers." It may be supposed that they lay their eggs upon some part of the plant, as the caterpillars which are produced from them feed upon the leaves. These moths belong to the FAMILY NOCTUIDÆ and the GENUS EUCLIDIA; one is named

9. E. GLYPHICA (*Linn.*): the Burnet Moth.

Head small, eyes somewhat globose; the horns, which are inserted on the crown of the head, are moderately long, and like bristles, but densely ciliated beneath in the males. In front of the face are two recurved scaly *palpi* or feelers; between these is concealed a spiral tongue, which, when unrolled, is as long as the horns. The thorax and body hairy; the latter is short, obtuse, and tufted at the apex in the male, but stout and cone-shaped in the female. Wings slightly deflected, and forming a triangle in repose: fore shanks very short, with an internal spine, intermediate furnished with several acute spines on the inside, and terminated by a very long and a shorter spur; hinder shanks not much longer, but stouter and hairy outside, with a very long and a short spur at the apex and a similar pair a little above them; the feet are longer than the shanks, especially the front pair; they are spiny, and composed of 5 joints, and are terminated by minute claws and cushions. The colour of the head and thorax in this species is orange-brown, the body black, with scattered ochreous hairs; the tail more ochreous; upper wings rosy-brown, with a dark brown patch at the base, a broad rich brown fascia across the middle, the ground-colour forming a band down the middle; sometimes there is an oval spot on the disc of the same colour, and towards the tip a triangular brown spot: underwings of an orange colour, the base and fringe black, as well as a border more or less rayed internally, and 2 waved lines from the anal angle across the disc: underside bright orange, with a black spot on the centre of each wing, and several of the lines and spots on the upper side slightly apparent. Expanse of wings 1 inch to 1 inch and 2 lines.

The caterpillars are termed Semi-loopers, from their peculiar action in walking. They are cylindrical, destitute of hairs, with

6 pectoral, 4 abdominal, and 2 anal feet. They are of a buff colour, and striped, with the head and belly brown. They feed on the purple clover, and also on a *Verbascum* (mullein), and conceal themselves generally between the lower leaves of the clover. They undergo their transformations in that situation in an elongated white cocoon. The chrysalis is brown, powdered with blue; the apex is spined. They remain in this state until the beginning of June, when the moths hatch: they are particularly attached to chalky districts.

The other species alluded to is

10. EUCLIDIA MI (*Linn.*): the Shipton Moth.

It is griseous; upper wings with a broad blackish band, margined with ochre, bi-lobed towards the interior margin, with a round black dot towards the costa, and a large lunate one, edged externally with ochre, beyond it: an ochreous stripe and a row of conical black spots towards the posterior margin; under wings black, with a large bright ochreous spot near the base, and two waved bands divided by black veins, often forming spots: fringe ochreous, spotted with black; margins of abdominal segments pale; under-side orange, with black spots and angulated lines: expanse of wings rather more than 1 inch. The caterpillars feed on clover, lucern, yellow medick (*Medicago falcata*), and grasses, and arrive at maturity the end of August. They are similar to those of *E. glyphica*, but are of a whitish lilac-colour, sometimes inclining to ochre, and striped. They have 12 legs, and form a loop in walking. They must be tolerably abundant, as the moths are very common and widely spread over England, Wales, and Scotland: they are found in May and June.

It appears that clover crops are not exempt from the inroads of the curious little worms called *Vibrio;* for it is stated in the 'Gardener's Chronicle' of the 20th of March, 1852, by Mr. Murcott, of Leamington, that he had discovered in the interior of red clover-seed some worms which he believed to be a *Vibrio.*

TARES.

Tares are infested by multitudes of insects, the larvæ of beetles, moths, and flies; amongst the latter is one which reduces the seed crop to a great extent. In July the flower-heads are often distinctly distorted; and on opening them numbers of maggots are found concealed in and amongst the calyces or cups of the flowers, where they eat into the base and entirely consume the incipient pod. These little larvæ are one line long, of an orange colour, tapering to the head, and blunt at the tail. In all probability they are the offspring of some species of *Cecidomyia* allied to the wheat-midge.

Vetches are also seriously injured by the maggots of a little weevil—

11. Apion Pomonæ, *Fab.;* A. cœrulescens, *Kirby.* (Fig. 16; 17 the same, flying and magnified.)

This weevil is larger than the clover Apions which have just been described; the *female* is of a black colour, entirely clothed with very short hoary hairs; head punctured; rough between the eyes; proboscis short, thick, hairy, punctured, apex attenuated and curved downward, dilated at the middle beneath (fig. 19); horns moderately long (fig. 20), inserted in cavities at each side of the proboscis towards the base; eyes prominent; the trunk black with a bluish tint, broadest behind, with a channel before the scutel, punctured, and with hairs; wing-cases covering the body, oval, narrowest at the base, bluish, with longitudinal punctured furrows, the spaces between them flat. A pair of ample, nearly transparent wings, are folded beneath the wing-cases in repose. The 6 legs are moderately long, the feet 4-jointed, the third bilobed, the fourth with 2 small claws (fig. 21). The *male* is similar to the female, but the proboscis is smooth, shining, and more attenuated; forehead between the eyes with two impressions (fig. 18); the horns with the first joint reddish at the base. It varies in length from $1\frac{3}{4}$ to $2\frac{1}{3}$ lines.

They fly well, even when the sun does not shine, especially the males. As early as May these weevils are found on the whitethorn, and are abundant until the autumn on heaths, fir-trees, and oaks; they also inhabit hedges, and must frequently abound in cultivated fields, as I have ascertained that the female deposits her eggs in the pods of the bush-vetch (*Vicia sepium*), and the following are my observations on the economy of this weevil. The end of July, 1847, I found in a field of tares or vetches (*Vicia sativa*), left for seed and partly ripe, a great number of the pods which were more or less distorted (fig. 12). On opening them I found the seeds partially eaten, some with only a hole in them (fig. 13), surrounded by abundance of brown and white excrement; other seeds were hollowed out, and a cell formed in each of them, of an oval form, but irregular; in these cells was either a fat maggot (fig. 14?* 15 the same magnified) or a pale ochreous pupa, which I at once saw was that of some weevil. On the 16th of August three specimens of *Apion pomonæ* hatched—one male and two females. When first disclosed they were of a dirty ochreous tint; the head and disc of the thorax soon became blackish, as well as the legs; the thighs

* Although I bred this weevil, I cannot be certain that these larvæ are not the maggots of some parasite.

having a large, and the shanks a small ochreous spot on each; and eventually the beetle became black and hard.

Experience shows that the bush-vetch (*Vicia sepium*) is difficult to cultivate on a large scale, the seeds being generally devoured by the larvæ of a species of Apion (probably *A. punctiger*, the *A. punctifrons* of Kirby), said to resort to this vetch only, which larvæ are again the prey of a species of minute ichneumon. *Apion subsulcatum* also inhabits the same plant.

Vicia sepium likewise affords nourishment to a minute caterpillar, which mines and feeds on the pulp of the leaves. It is the offspring of a beautiful little moth included in the FAMILY TINEIDÆ, and forms one of the members of a rather numerous group or GENUS which is recognised by modern authors as LITHO COLLETIS, and has been described by Zeller as

12. L. BREMIELLA.

"The head is fuscous, face and palpi silvery; antennæ fuscous, the tip whitish in certain lights; anterior wings rather dark saffron, with a short, straight basal streak about a third of the length of the wing, dark, margined on both sides; in the middle is an angulated silvery-white fascia, margined with black internally, and with a few black scales on its outer margin; beyond are three small silvery-white streaks on the costa (the third sometimes wanting); they are internally margined with black. Intermediate between these are two larger triangular silvery-white spots on the inner margin, dark-margined on both sides; on the apex of the wing lies a rather small oval black spot; hinder marginal line dark fuscous; cilia beyond pale grey. Posterior wings grey, with paler cilia."

Expanse of the wings $3\frac{1}{2}$-$4\frac{1}{2}$ lines.* The larva mines the leaves of various species of *Vicia*. Mr. Stainton found them, the end of September, by the side of a wood. The leaves at that time contained full-grown larvæ and pupæ in some abundance. The moth appeared a few days after. There are evidently two broods in a year: the caterpillars of one feeding in July, those of the other in September. Some of the latter become moths in October, whilst others remain in the chrysalis state until the following spring. I am indebted to Mr. J. W. Douglas for the following additional observations relative to the singular economy of this little insect:—

"I have enclosed a few leaves of *Vicia sepium*, in which the pupæ were, to show the bladder-like effect produced by the feeding of the larvæ. The two skins are quite separated. We do not find these larvæ on every plant, but, where they do occur, every leaflet on a stem is frequently tenanted. It has been remarked, in Germany, that this species is found on the *Vicia* only when it grows at the margin of woods, and our experience in this country hitherto agrees with this."

Mr. Douglas has also kindly communicated to me notices of the following species of some allied minute moths whose economy

* Stainton, Entomologists' Annual, 1856.

is connected with the trefoils; but as they are not known to affect the crops, we need only refer to them here.

13. Gelechia Anthyllidella. *Hubner's Tineæ*, fig. 330.

The caterpillars feed in April and June on the united leaves of the red and white clovers, *Anthyllis vulneraria* and *Onobrychis sativa*: the moths hatch in May and August. Another species is

14. Coleophora Discordella, *Zeller. Linnæa Entom.*, vol. iv. p. 301.

In spring and autumn the caterpillars are found in little cases attached to the leaves of *Lotus corniculatus*, and the moths from them make their appearance in June and July. A third species of these little moths is

15. Coleophora Deauratella, *Lienig. Isis von Oken* for 1846, p. 295.

The moths being always found in clover-fields, it is presumed that the caterpillars feed upon the leaves, but at present they are unknown.

On the 12th of February, 1841, Professor Henslow sent me some tares; at the base of the calyx were 2, 3, or 4 little maggots, which had eaten out the germen, but sometimes without touching the base of the pod or the corolla (fig. 22). They were of a pale yellowish-white, with orange, forming an interrupted line down each side of the back, and spreading towards the apex, which was slit; they were granulated or punctured, with a pair of short rigid bristles on each side of the head (fig. 23; 24 the same magnified). They were probably the larvæ of some Apion, but they all died, owing to the tares being kept too dry.

On the 12th of July, 1848, I examined about an acre of vetches in a field, three-quarters of which had the flower-heads distorted, and could produce very little or no seed. The leaflets in many instances were blotched with brown, and on opening the heads I found numbers of maggots concealed in and between the calyces; they ate into the base, and were visible only on forcing open the calyces: some of the heads were advancing to flower, and in the withered flowers were one or two of these maggots, which had entirely consumed the incipient pod. Whether these were the maggots or not of *Apion pomonæ* I am unable to say. At the same time there were also many ochreous apterous larvæ of some *Thrips*, and likewise little lead-coloured transparent ones running amongst the heads of flowers, which were the larvæ of a *Nitidula*, or some other little beetle. These were accompanied

by a minute species of *Acarus*, or mite, which fed upon the *Thrips*.

Sainfoin.

It is the practice in chalky districts to sow sainfoin, which is kept down for some years; and when the land is again broken up it is sure to yield a plentiful crop of wireworms. It is customary to burn the surface after paring it; but this does not always preserve the succeeding crop of turnips, &c., from the ravages of the wireworm. Mr. W. Leyland Woods, of Chilgrove, near Chichester, informs me that part of a field so treated produced a good piece of Swedish turnips, whilst the rest of the field failed. He observed that when the land was pared in March there was no injury to the crop, but the longer the work was delayed in the spring the less was the hope of retaining the plant. Mr. Woods suggested watering the land with gas-tar-water, but whether this proved an effectual remedy I have not learned.

Sainfoin is, like most of the other trefoils, the favourite resort of the little weevils to which we have so often alluded in this report. One is named by Mr. Walton

16. Apion Hedysari.

The *male* has been named by Schönherr *A. livescerum*, and the female *A. translatitium*.

It inhabits the sainfoin (*Hedysarum onobrychis*), and is found in chalky districts in Kent, in abundance, from May to October. Mr. Walton describes this Apion as of a

"plumbeous black colour, glossy, sparingly clothed with fine cinereous hairs; head subquadrate; the vertex adjoining the thorax, smooth; the frons posteriorly slightly convex, closely punctured between the eyes, commonly flat, sometimes depressed, longitudinally rugose-punctate, with one or two impunctate striæ, more or less distinct; eyes, prominent; rostrum, moderately stout, nearly as long as the head and thorax together, curved, a little attenuated in front, rather thickly punctulated throughout, black and slightly glossy; antennæ medial, rather longer than the rostrum, totally black. Thorax very little longer than broad, sub-cylindrical, broader behind than before, the anterior margin elevated, laterally scarcely dilated, convex above, coarsely and thickly punctured posteriorly with a deep dorsal channel more or less abbreviated in front, plumbeous, black, and shining. Scutellum, triangular, black; elytra, long-obovate; the shoulders nearly rectangular; the humeral callus elevated; convex above, deeply punctate-sulcate, the interstices flat, transversely rugulose, sometimes coriaceous, greenish blue, rarely blue or blue-black; legs, moderately long, black. *Male*, $1\frac{1}{2}$-$1\frac{2}{3}$ line long.

"The *female* differs in having the head narrower; the rostrum longer, slender, filiform, and shining; the antennæ inserted behind the middle of the rostrum." *

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* *Vide* Ann. and Mag. Nat. Hist., vol. xiii. p. 49.

Nothing is at present known of the transformations of this weevil; but as it is so abundant in the flower-heads of the sainfoin, and the above accurate description will enable the naturalist to identify the species, I hope that ere long its economy will be ascertained.

We may notice that *Lotus corniculatus* (the common bird's-foot clover) supports *Apion loti*, which is abundant on that plant in June; and the flowers of the same plant are sometimes strangely metamorphosed in appearance by a little midge called *Cecidomyia Loti*.

Apion Ervi and A. Lathyri are found on *Lathyrus pratensis* (everlasting tare).

Apion Viciæ is plentifully found upon the wood-vetch (*Vicia sylvatica*).

Lathyrus Nissolia (crimson grass-vetch) is particularly subject to the depredations of an apion.

Another beetle has recently been observed to injure the tares; and were it to appear annually in such great abundance as it did on one occasion, its ravages would prove a great loss to the cultivator. In July, 1850, Mr. F. Bond exhibited before the Entomological Society of London the larvæ and beetles of a species, named *Chrysomela polygoni*, which had destroyed many acres of tares in Cambridgeshire. It also inhabits the dock, sorrel (*Rumex acetosa*), and knot-grass (*Polygonum aviculare*), from whence the beetle receives its name of Polygoni. On these plants it is generally abundant from the early spring to midsummer.

17. Chrysomela (*Phædon*) Polygoni, *Linn.*

It is oblong-ovate and very convex (fig. 25; 26 the same magnified); the mouth comprises an upper lip (fig. 27), two mandibles or jaws for biting (fig. 28), two maxillæ with two palpi or feelers (fig. 29), and an underlip with two small feelers (fig. 30); the horns are moderately long, black, eleven-jointed, slender at the base, and thickened at the apex into a club (fig. 31): it is finely punctured; head small, greenish, or deep blue; thorax convex, broader than long; the lateral margins not thickened, shining, entirely reddish; wing-cases rather more deeply punctured than the thorax, violet-blue or green; beneath them is concealed an ample pair of wings: breast, middle of the underside of the thorax, and the abdomen, blue; tip of the latter and the shortish legs reddish. The feet are slender and four-jointed (fig. 32): length $1\frac{3}{4}$–$2\frac{1}{2}$ lines.

The lucern in France (*Medicago sativa*) suffers severely from a beetle which does not inhabit England. I shall, therefore, only briefly notice its economy. It is the

18. Colaspis atra

of authors, which eats off the leaves in the perfect as well as in the larva state, leaving only the foot-stalks; so that, instead of getting four crops, as the farmer ought to do, he rarely gets two. Thus this insect is a worse enemy to the lucern than the *Apion apricans* is to the clover.*

Clover and artificial grasses are said to suffer from the inroads of the ladybirds, which is a very curious fact, the favourite food of the British species being the *aphides*, as we have shown in an early Report.†

19. Coccinella impunctata

is reported by Dr. Hammerschmidt and Mr. Heeger to do mischief in its larva state to various sorts of clover, the tare, sainfoin, and lucern (*Medicago sativa, Linn*), by consuming the cellular tissue of the leaves. The larva is yellowish-white, with small green spots, the upper side clothed with prickles. It changes to a pupa of similar colour, and slightly hairy. The beetle is nearly semi-globose, yellowish-red above, pitchy beneath, a spot on the thorax, and the legs are reddish-brown.

It is in dry seasons and poor soils that the clover suffers most from these insects, as the produce is then so small that they are not disturbed by repeated mowing; whereas in moist seasons a more rapid growth is acquired, and, the crop being often cut and carried from the field, the insects cannot pass through their metamorphoses. This ladybird is common everywhere in Germany annually; but I do not remember its occurrence in England: at all events it does no mischief here.

Plant Lice.

The clover crops do not seem to suffer from the attacks of *aphides;* but vetches, like peas and beans, are frequently infested by them.

20. Aphis Viciæ, *Fab.;* A. Pisi, *Curt.*

I have found this species in abundance, in May and June, on vetches. At that time the apterous females, as I presume them to have been, were very large and of a bright green colour. In the middle of June I observed families of all sizes of the same species infesting the heads of grey peas: these were also all apterous; but in the beginning of July the winged specimens made their appearance, and were no less plentiful on the broom.

Mr. F. Walker, who is so well conversant with the economy of the *aphides*, has favoured me with the following observations on

* *Vide* Ann. Ent. Soc. de France, 1844, p. 271.
† Journ. Roy. Agr. Soc., vol. iii. p. 49.

the species just alluded to. The variety of names it bears, and the multitude of plants which this plant-louse inhabits, will give some faint idea of the time and labour required in the investigation of such subjects.

Mr. Walker says—

"I believe that the synonyms of *Aphis pisi* (the green dolphin) stand thus:—*Aphis Ulmariæ*, Schrank, 'Fauna Boica;' *Aphis onobrychis*, Fonscolombe, 'Ann. Soc. Ent. France,' x. 169-9; *Aphis pisi*, Kaltenbach, 'Mon. Pflan.,' i. 23-11, Curt.; *Aphis lathyri*, Sir Oswald Mosley, 'Gard. Chron.,' i. 684. It feeds on *Spiræa Ulmaria*, *Genista Anglica*, *Spartium scoparium* and *Cytisus*, *Colutea arborescens*, *Lathyrus odoratus* and *pratensis*, *Pisum sativum* and *arvense*, *Phaseolus vulgaris* and *multiflorus*, *Vicia sepium* and *sativa*, and *Faba*, *Ervum*, *Hedysarum*, *Onobrychis*, *Lotus corniculatus* and *uliginosus*, *Trifolium pratense* and *repens* and *filiforme*, *Ononis repens* and *hircina*, *Geum urbanum*, *Epilobium montanum*, *Capsella bursa-pastoris*, *Chærophyllum temulentum* and *sylvestre*, *Artemisia absinthium*, and *Tanacetum vulgare*."

The viviparous wingless female.—Large, yellowish-green, or green, sometimes rose-colour or purple; antennæ brown or black, nearly as long as the body. Abdomen attenuated at the tip; tubes about one quarter the length of the body; legs long; knees, tarsi, and tips of tibiæ, black or brown.

The viviparous winged female.—Like the wingless female. Thorax buff colour; wings vitreous; tips of the veins very slightly clouded.

The winged male.—Black or brown; antennæ longer than the body; femora and tibiæ more or less yellow towards the base.

Snake Millipedes.

On the 21st May, 1845, I received an interesting communication from Mr. Frederick Kelly, of Northfleet, Kent, relative to his crop of lucern, which was suffering much from the presence of large numbers of a snake millipede, which, on examination, I found was a species named *Julus Londinensis*.* The plants forwarded to me had the stems deprived of the bark close to and under the surface of the soil, and no doubt had been thus injured by the Julus. The leaves were dead on the branches. As the snake millipedes have been described and figured in this Journal,† and their habits and economy thoroughly investigated, I shall only add Mr. Kelly's own account of the damage done to his crops of lucern by *J. Londinensis*. It was at the above date "in great numbers round my lucern-plants. All I send were taken this morning from two plants; these worms [millipedes] get amongst the lower shoots on the surface of the ground, some few burying themselves a little below." Mr. Kelly concluded, from the yellow and faded appearance of the plants, that these animals

* *Vide* Roy. Agr. Soc. Journ., vol. v. p. 228. † Ibid.

were the cause, for at the roots of the green and healthy plants he could find none of the millipedes. There were also a few wire-worms on the ground, which might, he thought, assist in the mischief. In order to destroy the wireworms, Mr. Kelly gave his land the year before a dressing of soda-ash. He further stated that this portion of the land, which was in beans when he wrote, was healthy and free from millipedes. Mr. Kelly then adds :—

"Thinking to destroy these dark-brown worms, I dressed a row of lucern, a week since, with soda-ash, putting a small quantity near each root; another row with a solution in water of soda-ash; and I tried a row with flour of sulphur. The dry soda-ash appears to have driven the greater part of the worms from the surface to a few inches below it; the solution appears to have nearly sent them away from the plants to which it was applied, but the plants themselves appear injured by the application, and I therefore fear to go on with it; the sulphur has produced no effects on either plants or worms, except that the latter have taken themselves out of immediate contact with it."

As the best modes of destroying the snake millipedes have been fully discussed in the Report already alluded to, we need not further comment on that part of their history.

Snails and Slugs.

As these animals frequently swarm in our fields and gardens, and unquestionably consume a large amount of the clover crops, we cannot introduce their history on a better occasion than the present. There are several species of snails which are denizens of our fields and hedges.

Snails and slugs being hermaphrodites, every individual is capable of producing eggs.

21. Helix Hortensis (called also *H. aspersa*)—the Garden Snail.

The eggs of this species are laid in heaps in the earth, amounting to a considerable number; I have found at least eighty in one cluster. They are globular, whitish, shining, and not bigger than large shot. In damp situations they soon hatch, when they become at once little, thin, transparent, and nearly colourless shells. They shortly increase to double the size, even when they have had nothing to feed upon; they then assume a dark ochreous colour, with three imperfect rings, composed of brownish dots and streaks, and a transverse line of the same colour next the pale lip or margin, and these spots seem to vary as the animal withdraws or extends itself, owing to the dark tints shining through the semi-transparent shell. As the snail grows, it has the faculty of enlarging the shell from its own secretions, and when full grown it is as large as a moderately-sized plum; it is convoluted, obliquely striated, of an ochreous colour, and variegated with pitchy spots, giving it a marbled appearance, and forming two or three transverse

bands: the lip is ochreous, the margin reflexed; the underside is smooth and white, with a pinkish tint. The inhabitant of the shell at this period is two or three inches long, when at full stretch: it is scored or wrinkled, like the lengthened meshes of a net, whitish, with the back and head of a pale inky or slate colour; the four horns are retractile, the superior pair being the longest, slightly tapering, with a globular knob at the extremity containing a black dot, which is probably the eye, and, if one of these sensitive horns be touched, it is instantly withdrawn and shortened: the two inferior horns are much smaller, and below these is placed the mouth.

Drought and cold are inimical to snails; they, therefore, are only in full activity in damp situations, and after showers in mild weather, when they come out to feed, giving the preference to the night. On the approach of winter they hide themselves and adhere closely to stones, palings, &c., and even to one another, by means of a slimy secretion with which they close the orifice of the shell: thus hermetically sealed, the air is entirely excluded. They there remain secure and dormant, and can thus retain their vitality for incredibly long periods, even for fourteen or fifteen years.

Two smaller snails, named *H. virgata* and *H. rufescens*, are in the utmost profusion on the borders of fields of every description, as well as pasture lands in chalky districts. In Kent they may absolutely be collected by bushels.

A large and handsome species, *H. nemoralis*, is exceedingly abundant in hedges, upland pastures, and clover-fields. Snails are a favourite food of the thrush and blackbird, as is evident by the number of broken shells one sees along hedgerows and banks where those birds resort, especially in the spring. It is also a singular fact that glowworms (*Lampyris noctiluca*),* and an allied genus named *Drilus flavescens*, feed upon snails.

Slugs.

The depredations committed by snails on the crops are insignificant compared with the ravages of slugs. There are few seasons of the year when slugs are inactive, for even in mild winters they are concealed in the earth and come out to feed; but it is in spring and autumn that they do the most mischief. This is so well known by every farmer and gardener, that we need only allude to that part of their history.

Slugs lay their eggs in humid spots, and they hatch in three or four weeks. I may mention that in pulling up some grass at the end of September I found numbers of eggs at the roots, with

* Curt. Brit. Ent., fol. and pl. 698.

multitudes of slugs and many snails. The slugs were of the milky sort, and I doubt not that some of the eggs, which were of the size of turnip-seeds, were laid by them. With them was also a pair of the large, ochreous rough slug, laying eggs, and on crushing them a string of full-sized eggs were protruded from each slug. The eggs were contained in a tubular vessel, and appeared then opaque-white, owing to the membrane covering them. These large eggs varied in form: they were principally oval, but a few were nearly globular, and some of them were conical at one end. They were ochreous yellow, and like bags of jelly. A few weeks previously I had found at the roots of another plant a large mass of these eggs.

The scientific name of slugs is

LIMAX.

They have four tentacula or feelers, which are very sensitive, and are concealed in repose. At the tips of the longer pair are placed the eyes. They have a fleshy shield covering a horny plate, and are, like snails, hermaphrodite, the aperture on the right side opening into the organs of generation and of respiration.

The species vary greatly in colour, and measure from half an inch to five inches in length. The first of the three commonest species is

22. LIMAX AGRESTIS (the Milky Slug).

It is whitish or ash-coloured, with black tentacula, either immaculate or with scattered black specks and a yellowish shield.

23. L. ATER (the Black Slug)

is furnished with deep wrinkles, and has a rough shield: it is sometimes deep black, pale or white beneath, with a yellowish mouth and a pale greenish ridge down the back. Sometimes it is of a dusky or chesnut colour, with a yellowish streak on each side. *L. empiricorum* is merely an adult variety of the former species.

24. L. MAXIMUS (the Black-striped Slug)

grows to the length of five inches: it is ash-coloured, sometimes spotted, or with a black shield and the body striped with black; or with fine whitish streaks, the lower one interrupted; or with the body edged with white.

Limax ater is recorded to have eaten sea-sand, paper, and meat.* *L. rufus* and *agrestis* are very partial to firm and crisp fungi and damp *boleti*; but of all the vegetables which slugs feed

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* Ann. Nat. Hist. for 1839, vol. ii. p. 310.

upon there are few, probably, more acceptable to them than clover and vetches.

Abundance of remedies for destroying slugs will be found in the 'Gardeners' Chronicle' and various works on horticulture; and it is not so difficult to decoy and destroy them in gardens; but in turnip and pea fields, young corn-crops, clover-layers, &c., their destruction is almost impracticable. I expect that ducks turned into our fields are by far the most effectual remedy; but no doubt, if cabbage-leaves or slices of turnips be scattered along the furrows, enormous quantities might thus be collected and given to the pigs. Wood-ashes, or charcoal-dust, are perhaps more efficacious than soot or lime. Salt sprinkled over the land is certain destruction to the slugs when they come forth at night, or after a shower, to feed: it should be scattered at the rate of four or five bushels per acre before the crop is sown. Lime-water is well known to kill slugs. The watering should be repeated as soon as possible, for slugs have the power of throwing off their slimy coating and crawling away; but a second sprinkling soon causes their death, as they are unable so speedily to secrete a fresh covering of slime. Nitrate of soda dissolved in water is another excellent remedy.

In alluding to these remedies I would observe that, as far as clover crops are concerned, their application seems to be impracticable; and I think it doubtful whether the presence of slugs in clover-fields be of any real consequence, except as regards the crop which is to follow.

Grass and Pasture Lands.

Although there is no portion of the globe which may not sustain insect life, whether hot or cold, wet or dry, high or low, barren or cultivated, yet, no doubt, woods, forests, and grass-land, have been from the earliest ages the homes and habitations of the insect race. Grass especially is the natural covering of the soil, which has been increasing in depth and bulk from the creation, not only from the natural and annual decay of vegetable matter, but from the manure produced by herbaceous animals and the labours of the insect race. These again attract certain birds which feed upon them, as well as upon seeds, and supply, no doubt, an enormous amount of guano. Insects have therefore revelled unmolested in their native haunts from the creation, through the pastoral ages to the present period, and such localities will ever be the head-quarters of this pigmy but formidable race, which, were it not for the natural checks provided by Providence, would overrun the earth and eventually annihilate all vegetation. It is accordingly to be expected that grass-lands would swarm with insect life, both above and below the surface; and being

thus the nurseries for the deposition of the eggs and the nourishment of the larvæ, it is naturally to be expected that a crop immediately succeeding fresh broken-up pasture-land would fall a sacrifice to the inroads of insects, unless special care be taken to eradicate the enemy by paring and burning before the corn or other crops be sown.

It also becomes more difficult to obtain good yielding crops in a mixed tenure of corn and grass-land, or in the neighbourhood of marshes, pastures, and grass-lands, as the insects bred there migrate to the adjoining arable lands, and often find food more agreeable to them than that which they have deserted, so that the click-beetles, moths, and crane-flies depositing their eggs, the farmer soon finds his land infested by wireworms, surface-grubs, and leather-jackets, to which his turnips, beet, and corn fall a sacrifice.

To make the farmer acquainted with the hosts of insects which find a home in pasture-land would occupy volumes; it will, however, answer every purpose connected with the object of these reports, if we lay before him the most important species which feed on the seeds, flowers, and foliage, those which live upon or in the stems, and others which consume the roots.

The tribe of insects which we shall first notice is the family of *Aphides*, or plant-lice. It is a confirmation of my views on this subject to find that the plant-lice which infest the wheat are generated on the panicles of grasses, as I learn from Mr. F. Walker, who has kindly communicated the following observations, and descriptions of two species.

25. Aphis Avenæ, *Fabr.* A. Granaria, *Kirby.* A. Hordei, *Kyber.* A. Cerealis, *Kaltenbach.*

Feeds on *Secale cereale*, *Triticum æstivum*, *Avena sativa*, *Danthonia strigosa*, *Hordeum vulgare*, *H. murinum*, *Bromus mollis*, *B. secalinus*, *Dactylis glomerata*, *Holcus lanatus*, *Glyceria fluitans*, *Poa annua*, and other grasses, and *Polygonum persicaria.*

Wingless female.—Colour red, green, brown, or yellow. Front convex in the middle, and with a distinct lobe on each side. Antennæ black, nearly as long or longer than the body. Abdominal tubes black, nearly one-fourth of the length of the body. Knees, tarsi, and tips of the tibiæ, black.

Winged female.—Brown, rarely green. Abdomen with a row of black dots on each side; tip yellow; stigma brown; wings vitreous; veins pale yellow.

26. Aphis dirhoda, *Walk.* Annals Nat. Hist.

Feeds on *Rosa centifolia*, *R. canina*, and *R. eglantina*, and migrates in the summer to different species of corn and grasses,

Secale, Triticum, Avena, Hordeum, Bromus, Dactylis, Holcus, and *Poa.* It feeds on the leaves of these plants, whereas *Aphis avenæ* prefers the flowers.

Wingless female.—Oval, pale greenish-yellow. Front prominent between the eyes; antennæ with brown tips, about one-fourth of the length of the body; abdomen brown at the tips; tubes with brown tips, about one-sixth of the length of the body; tarsi pale brown.

Winged female.—Pale green, or yellowish-green; antennæ brown or black, much shorter than the body, as long as the body, or longer than the body; thorax buff; lobes pale brown; abdominal tubes sometimes with black tips, one-sixth, or nearly one-fourth, of the length of the body; tarsi and tips of the femora and of the tibiæ brown or black; wings vitreous; stigma and veins brown; costa pale green, or pale yellow.

Oviparous wingless female.—Straw-colour, buff, orange, or rose-colour.

Winged male.—Buff or pale orange; head and disk of the thorax brown or black; antennæ black, much longer than the body; abdomen with a black line along the back, and a row of black dots on each side.

In 1841 Mr. J. G. Lowder made some remarks upon the failure of the seed of *Festuca loliacea*, which he attributed to the presence of plant-lice. In a letter addressed to this Society he says:—

"This failure, I am much inclined to think, will be found to be occasioned by the ravages of an insect of the *Aphis* tribe; for on 10 out of the 11 seed-stalks which I first collected I observed the heads of many such insects closely imbedded between the valves of the flowers, obviously in the act of feeding, and most probably extracting the saccharine matter. The germ, thus injured, must necessarily be barren and unproductive."

Having had no opportunity of examining the species alluded to by Mr. Lowder, I am unable to give their name, but I conclude they are some of the aphides described by Mr. Walker.

It is recorded that the slender fox-tail grass, spear-grass, or black-bent (*Alopecurus agrestis*), which is so troublesome a weed amongst wheat, has a large portion of the seeds annually destroyed by a minute orange-coloured maggot, no doubt the offspring of a *Cecidomyia*, and probably the "wheat-midge." Indeed one can scarcely examine a flower-spike of any grass without finding an abundance of these minute orange maggots; but as the species of midge has not been yet ascertained, I shall simply refer to their history and economy in a former report,* where the wheat-midge, *Cecidomyia tritici*, is described and figured.

Meadow fox-tail grass (*Alopecurus pratensis*) is subject to the

* Roy. Agr. Jour., vol. vi. p. 139, pl. M.

depredations of the larvæ of a species of *Musca*, which devours the seed so much that in many spikes scarcely one will be found perfect. I wish I could give the name of this fly, but at present its transformations seem to be unknown. Mr. H. Gibbs informed this Society that all the species of *Agrostis* likewise were subject to the depredations of a little orange-coloured larva to such an extent that in most cases not more than one seed in a dozen ever vegetated on sowing. These larvæ are the prey of *Cimex campestris* (a little plant-bug), whose rostrum seems peculiarly formed for searching the husks of the grasses.*

The GENERA *Chlorops* and *Oscinis* are next deserving our notice. There can be no doubt that these flies are generated to a wonderful amount in the stems of grasses, yet the economy of the various species so generated has, I believe, as yet escaped the notice both of agriculturists and naturalists. In all probability the grasses most affected by these flies are species of *Avena* and *Lolium*, which bear the greatest affinity to the oat and wheat; but this is merely my own conjecture.

As the history and economy of certain species of these flies were fully investigated and discussed in a former report,† we need only refer to it for further information: the figures and descriptions there given will satisfy the inquirer who wishes to become acquainted with the various species.

EARWIGS.

Earwigs are so abundant everywhere, and occasionally swarm in such countless myriads, that they not only become troublesome even in our houses, but are one of the greatest pests wherever flowers, fruit, or vegetables are to be found. The grasses, when in flower, are a favourite haunt of these insects; and although the farmer does not suffer such severe losses from their inroads as the florist and horticulturist, yet, no doubt, they often assist in the destruction of young crops, eating the plants off as soon as they shoot from the earth. Earwigs may not only injure the crops in their early stages of growth, but amongst wheat, grasses, &c., the fructification may be affected by their feeding on the pollen. They compensate, however, in some measure for the mischief which they produce by the destruction of the *Aphides* and the *Thrips*. They are most voracious insects, coming out at night from their haunts to feed, and at that time they will attack even bees, especially several wild ones, called *Osmia bicornis*, *Colletes*, and *Anthophora*, which are sometimes almost exterminated by them. They devour the pollen, pupa,

* Kirby and Spence, sixth ed. vol. i. p. 146.

† Roy. Agr. Jour., vol. v. p. 489, pl. L., figs. 23-26. Ibid., p. 494, pl. I., figs. 31, 34.

or the imago indifferently ;* and when confined and hard pressed by hunger, they will attack and destroy each other. They live all the year round, retiring in winter into crevices in the soil, under clods, stones, the loose bark of trees, &c., where they seem to remain in a semi-torpid state.

Their economy is in some respects rather remarkable, for the female, after she has laid her cluster of little oval, opaque, yellowish eggs, under a fallen leaf, or in any other sheltered spot, sits and nestles upon them as a hen does on her eggs, and probably also protects and feeds her young. Moreover, the earwig is an active creature as soon as it is hatched, and bears a considerable resemblance to its parent, but it is much smaller of course, and different in colour, destitute of wings, and the forceps are straighter and not horny. When they have arrived at what may be termed the pupa state, they present a still greater resemblance to the mature insects, having rudimentary elytra. They cast their skins from time to time, and immediately after this operation they are of a yellowish-white colour, excepting the black eyes. Having arrived at their perfect and final state, both sexes are then provided with wings, which are most curiously folded upon the back, and nearly concealed beneath the little wing-cases. That these organs are sufficiently ample to sustain them in flight is not to be doubted, and the fact of one of the species, named *Forficula borealis*, having been taken in July on the wing, in the heat of the day, is a confirmation of the general opinion. It is, nevertheless, not the less remarkable that, having this power, they should so seldom avail themselves of it. It appears, however, that they take wing on moonlight nights. Earwigs now form a distinct ORDER, termed DERMAPTERA, and are included in the FAMILY FORFICULIDÆ. There are two species abundant in this country ; the first is named

27. FORFICULA AURICULARIA (*Linn.*).

Head ovate ; eyes small, lateral, and oval ; the two horns inserted before the eyes, moderately long, thread-shaped, pubescent, and 14-jointed. The mouth is composed of an upper lip, of a transverse oval form ; on either side is a horny mandible or jaw, trigonate, one cleft at the apex, the other concave and forming an angle at the middle. Opposed to the upper lip is the under lip, which is elongated, pilose, and dilated. The two palpi or feelers are 3-jointed and rough, with short hairs. On each side are placed the maxillæ, which are rather elongated, furnished with two slender lobes, the internal one rigid, pointed, and cleft at the apex, the interior margin fringed with spines

* Zool. 7, 2372.

above and hairs below, external lobe curved, linear, rounded at the apex; palpi or feelers rather long, hairy, and 5-jointed; the thorax or trunk not larger than the head, margined, orbicular-quadrate; scutellum concealed; the elytra or wing-cases attached beneath the thorax, and lying parallel on the back, oblong, coriaceous, without nervures; the two wings are delicate, ample, with numerous radiating nervures, folded several times, one lying under each elytron, with a small portion projecting beyond it; abdomen broader than the elytra, 9-jointed in the male, with a small elevated knot on each side of the second and third joints, and also at the apex—7-jointed in the female; the apex furnished with a pair of moveable forceps, curved and toothed in the male, curved only at the apex in the female. It has 6 legs, hinder pair a little the longest; thighs thickened; the feet 3-jointed, the second joint is heart-shaped, and the third terminated by two slender acute claws.

The *male* is 7 lines long; ochreous, head rufous, disk of thorax pitchy; abdomen castaneous; forceps much shorter than the abdomen, and very much curved. *Female* a little smaller; forceps nearly straight, attenuated, and finely serrated internally, except at the apex, which is curved. The other species has been named

28. F. Borealis, by *Leach*,

from its having been observed by him in the north of England and Scotland; but it is abundant everywhere. The male is 8 or 9 lines long, ochreous; horns lurid, excepting the basal joint; head rufous, eyes black; disk of thorax pitchy; elytra lurid, the apex of the folded wings internally brown; abdomen chesnut-coloured, pitchy at the base and apex; forceps nearly as long as the abdomen, moderately curved, stout, chesnut-coloured, ochreous at the base, with a strong tooth on the inside of each towards the base, where there are smaller teeth. The specimens I take to be females have the forceps less curved than in *F. auricularia*.* It may be well to observe that there is a little earwig called *Labia minor* which might be taken by those who are ignorant of the transformations of these insects for a young earwig, but it is totally distinct from those just described; it seems to be attached to muck-heaps and dunghills, from whence it sometimes emerges in swarms, covering everything around, having two beautiful wings, and delighting to fly in the sunshine.

No doubt earwigs have many enemies in the smaller birds and reptiles, but I am not aware of any parasites having been discovered to keep them in check. There are some beetles,

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* *Vide* Curt. Brit. Ent., fol. and pl. 560.

however, which prey upon them, and one of the most formidable enemies of the earwig is a long, black Rove-beetle, named

29. Staphylinus (*Ocypus*) olens, *Fab.* The Fetid Rove-beetle, well known in this country as the Devil's Coach-horse.

It is of a dead-black colour, thickly punctured all over with the minutest points, and thickly clothed with very short but stiff and fine black hairs, which in the sun appear iridescent. The head is very broad and depressed, as well as the rest of the body; the eyes are small and lateral; the two horns are rather short, a little tapering, pubescent, and 11-jointed, the basal joint being long, and the terminal one somewhat claw-shaped: it has two uncommonly strong and powerful jaws, which can be opened very wide; they are curved, with an edge for cutting, and there are two teeth on the inside of each, with a fringed, leathery appendage near the middle; the upper and under lips and the maxillæ form the rest of the mouth, together with the four feelers, which are hairy and jointed, the external having four joints, the others, which are much smaller, being only 3-jointed: the trunk is somewhat orbicular; the scutel is small; the elytra when closed are nearly quadrate, and cover the two wings, which are much shorter than the body, and are folded up in repose; they are stiff and yellowish, with a few nervures, and are not sufficiently ample to enable the animal to fly; the body is more than half the entire length of the beetle, and tapers towards the apex, being composed of six and seven segments, with a little hairy process on each side of the apex; the six legs are strong, the anterior coxæ are very stout and powerful; the thighs and shanks are short; the latter have spines at the apex, and are bristly all over; the feet are 5-jointed; the anterior are short, ovate, dilated, and very velvety or cushioned on the under-side; the first four joints are heart-shaped, the fifth is slender and clavate, terminated by two claws; the other feet are linear, the basal joint is the longest: length sometimes $1\frac{1}{4}$ inch.

The Fetid Rove-beetles are abundant during the whole of September in meadows and wherever grass grows, and they continue so in some seasons to the middle of October, or until frosts set in; at that time we see them in roads and the footpaths in fields and pastures, where they are often trodden upon during the night, at which period they come out from under stones and other hiding-places to ramble about for prey. There can be no doubt that many of these beetles live through the winter, as we find them occasionally in the month of March. It is one of the largest Rove-beetles (as the *Staphylinidæ* are called) in Europe, but it seems to be principally an inhabitant of the more temperate parts, and it is very remarkable that it was never found

in Sweden by Linnæus, to whom it seems to have been unknown; it is said at the present day to be rare in that country, and is only met with in the southern provinces.

The larvæ of this insect are as ferocious as the parent beetle, feeding entirely upon animal substances, and even devouring each other. They live principally underground, and in turning over the soil they are frequently met with in the spring. As they are then full grown, the eggs are, it may be presumed, laid the previous autumn, and the larvæ continue feeding throughout the winter.* When they change to pupæ, it is said that they retire under stones, and form an oblique hole in which to undergo their transformation, which takes place in a few days after, and at the end of fifteen or sixteen more the beetle is produced. It is at first yellowish, but attains its black colour in about twenty-four hours. The larvæ have a head somewhat like the beetle, but the jaws are not toothed internally; they are black and shining, as well as the three first or thoracic segments: the remainder of the body is ash-coloured, spotted with darker spots, a line down the back, and the sides ochreous and hairy; the mouth, horns, and six legs, rust-coloured; the tail is furnished with a prehensile foot and two slender hairy appendages; the pupa is entirely ochre-coloured. (We have taken this description of the larva and pupa from M. Blanchard's notice of them in Guérin's 'Mag. de Zool.,' where figures are given in plate 165.)

The Fetid Rove-beetle must destroy a great number of earwigs, for, on confining one under a tumbler with some of those insects, the beetle despatched and ate four of them in the space of an hour and a half. It is curious to see the beetles seize the earwigs, dividing their bodies, clipping off their heads, eating the contents of the body, and rejecting the horny covering.

Of all the insects to which pasture-lands are a permanent resort, there are none more abundant and more injurious to the neighbourhood than those which live underground and feed upon the roots of most of the other plants, as well as of the grasses, which grow in meadows, marshes, and pasture-lands.

Amongst these are the caterpillars called "surface-grubs," of which we have spoken at large in a former Report.† Probably a very large number of species of this family are of similar habits. Of *Noctua* (*Agrotis*) *exclamationis*, *A. segetis*, and *Triphæna pronuba*, we need here only record the ravages; but we must notice more particularly the economy of another moth, which sometimes destroys in its larva state a very large portion of pasture-land. Although it is in the mountainous districts of

* It is, however, far from improbable that they remain in the larva state for a much longer period.

† Vol. iv. p. 108.

Europe that these caterpillars have so greatly abounded, yet in this country they are far from uncommon. They are also abundant in Scotland and Ireland. The moths appear in July and August; they belong to the FAMILY NOCTUIDÆ, and have received the name of

30. NOCTUA GRAMINIS: *Linn.* The Antler Moth.

This species has also the generic names of *Charæas*, *Episema*, and *Cerapteryx*.* The horns are bipectinate in the male, slightly pubescent in the female. The palpi or feelers in front of the face conceal a slender spiral proboscis, which is as long as the horns. The males are smaller than the females. It is reddish or fuscous brown: wings slightly deflected when at rest: superior wings with pale nervures, the central one ochreous, an oblong spot at the base of the same colour, an oblong conic spot towards the middle, and an oval or ovate one above it duller; beyond the middle is an ear-shaped spot, resting on a trifid character, both ochreous; these are relieved by a dark-brown or black tint, with a line of spots of the same colour between the nervures near the posterior margin: under wings and body blackish or smoky, sometimes palest at the base, the former with a dark spot in the centre: the tip of the body in the males is ochreous, with a smoky line along the middle in the upper wings: expanse of wings 1 inch 6-8 lines.

The caterpillars are an inch long, with 6 pectoral, 8 abdominal, and 2 anal feet, smooth, and of a dull grey-brown or blackish colour, with 3 yellow lines down the back and sides, which meet at the apex; the first and last segments are protected by a horny, smooth scale. They are full-grown about midsummer, when they often leave their subterranean abodes in search of some eligible spot wherein to change to chrysalides, which they do in slight webs, in moss, under stones, &c. The food of the caterpillars consists of all kinds of tender grass, but, according to Linnæus, they will not touch the *Alopecurus pratensis* nor the *Trifolium pratense*. They live on the roots and eat away all shoots. This insect has been particularly observed in Sweden, in Norway, in Northern Germany, and even in Greenland, and does great mischief to grass-plots and meadows. It is also recorded to have done very great injury in the eastern mountains of Georgenthal, as well as at Töplitz in Bohemia, where caterpillars were in such large numbers that in four days and a half 200 men found 23 bushels of caterpillars, or 4,500,000, in the 60 bushels of mould which they examined. In Germany it seems to be confined to high and dry districts, and it never

* Curt. Brit. Ent., fol. and pl. 451.

appears there in wet meadows or marshes, but its devastations are sometimes most extensive, as happened in the territory of the Hartz in 1816 and 1817, when whole hills that in the evening were clad with the finest green, were brown and bare the following morning; and such vast numbers of the caterpillars were there that the ruts of the roads leading to the hills were full of them, and the roads, being covered with them, were even rendered slippery and dirty by their being crushed in some places.* It is suggested by Köllar to dig or plough a deep and broad trench round the affected spot, and then turn in pigs to eat up the caterpillars. Rooks and crows are also very serviceable in rendering their assistance. The continued rains which often fall about midsummer generally keep this enemy in check, as they bring destruction to the caterpillars when they are changing their last skin, as was the case in Germany. I well remember, when Mr. Dale and myself visited Keswick in July, 1827, that the grass on a large portion of one side of Skiddaw appeared dead, and we found multitudes of the caterpillar of the antler moth crawling about. In other parts of England I have observed the moths on heaths, in meadows, on the flowers of the ragwort, and even in marshes, which induced me to believe that they were bred there.

To arrest the ravages of these caterpillars the following remedies have been proposed,—the application of "a strong dressing of lime to the land in the spring, or watering the fields and meadows with lime-water in damp weather, or strewing the ground with ashes of coal, peat, or turf, or lye-ashes."

Occasionally on the Continent the ravages of the caterpillar of the *Agrotis segetis* (above referred to) are fearful, as will be seen by the following account from the 'Ann. Soc. Ent. de France,' iii. 19:—

"M. Louis Coulon, of Neufchâtel in Switzerland, stated that the pasturage of the Jura had been devoured in June (1833) to such an extent by the caterpillars of *N.* (*Agrotis*) *segetis* and the larva of *Galeruca tanaceti* that they were not able to put the cattle there. The first devours the roots, the second the extremities of the grass which had not yet withered in consequence of the ravages of the caterpillars. People some way off even heard the noise which these larvæ made in eating, and the yellow tints which spread over the pastures indicated their presence."

As this beetle is frequently exceedingly abundant in England, I will add a description of it. It belongs to the FAMILY CHRYSOMELIDÆ, and is named

31. Galeruca Tanaceti, *Linn.*

It is oval, and dull black, deeply and roughly punctured: the horns are not so long as the body, filiform, pubescent, and 11-

* Köllar's Treatise on Insects, London Trans. 105-136.

jointed: the thorax is broader than long, the sides rounded: the wing-cases are much broader, oval; they have about 5 faintly elevated lines: wings ample: body of the female sometimes very large and extending beyond the elytra: the thighs are stout: the shanks thickened towards the apex, which is bristly: the feet are broad and 5-jointed; the third joint is bilobed, the fourth very minute, the terminal joint clavate, with 2 claws: length from 4 to 6 lines. The larva of this beetle is somewhat lanceolate, composed of about 12 segments, spined and brown, with 6 pectoral feet: pupa ochreous (Rœsel, v. 2, class 3, t. 5). This common species inhabits the north and south of England. It is found in May, June, September, and October, in chalk-pits, and sometimes in profusion on sand-hills near the sea. It occasionally frequents the ears of barley, and sometimes the beetles are of a brown colour.*

The genus of Gnats comprised under the name of *Tipula* are in the larva state amongst the most formidable enemies which the farmer and gardener have to contend with. There is not a crop of corn, of turnips, mangel-wurzel, or potatoes, which may not fall a sacrifice to what have been significantly termed, from their toughness, "leather-jackets," and there are but few crops in the kitchen-garden which escape their attacks. Wherever grass will grow, however scanty, these larvæ are generated, and of course pasture-lands, meadows, and marshes give birth to myriads of crane-flies, which issue forth from their subterranean abodes as they emerge from their pupa cases, during summer, until late in the autumn when frost sets in, to pair and scatter their eggs over the length and breadth of the land. There are upwards of thirty British species of the genus *Tipula*, all of which find a home on grass-lands; but there are only three whose economy has been sufficiently investigated to enable us to speak positively as to the damage they occasion in fields and gardens: they are—*T. oleracea*, Linn.; *T. paludosa*, Meig; and *T. maculosa*, Hoff. As these species have been carefully described and figured in a former Report, we shall not here enter further upon their history. (Roy. Agr. Jour., vol. x. pp. 90 and 91, pl. V. fig. 35-39; also p. 92 and pl. V. fig. 40-44.)

Another most destructive larva in pasture-lands is that of a pretty beetle called

32. Anisoplia Horticola.

This beetle is exceedingly abundant in May and June in corn-fields, hedge-rows (especially when the whitethorn is in flower), and grass-lands. We will now fulfil our promise, made

* Curt. Brit. Ent., fol. and p. 371.

in a former Report, of calling attention to the economy of these beetles and the means which have been suggested for the destruction of the larvæ (for descriptions and figures *vide* Roy. Agr. Journ., vol. v. p. 476, pl. K. fig. 13, 14). They are so abundant every year, and so well known in every part of the kingdom, that these beetles have been called by various names, as field-chafers, May-bugs, bracken-clocks, fern-shaw beetles, chovies, &c. The female, having deposited about a hundred eggs in the earth, dies, and the larvæ hatch and commence their attacks upon the roots of the grass. Although they are mischievous in gardens, it is in pasture-lands and lawns that they commit the greatest ravages; by their consuming the roots, the grass dies; the dead turf becomes rotten, and will sink in patches under the feet, owing to the burrows which the maggots have made in the earth; and the rooks and starlings add to the disorder by pulling up the turf to feed upon them. The May-bug maggots were exceedingly abundant in the autumns of 1839 and 1840 in Hampshire and Gloucestershire, and again in 1844 in various localities. It is stated that they continue feeding for three years, and they generally reside about an inch beneath the turf; but as winter approaches they retire deeper into the earth; and even in November, when frost has set in, they have been found buried a spade deep. From the large size of most of them at this period, I expect they are generally full-grown and prepared to enter the pupa state, for which purpose they form cells in the earth, and in all probability remain in that quiescent state until the following spring, when the beetles emerge about the time the roses flower. They then feed on the anthers and pollen, consuming also the petals and riddling the leaves. The May-flowers are likewise an acceptable repast. When these no longer afford them a supply of food, they resort to corn-fields to feed on wheat and oats; still later they have been known to congregate on acacias, and occasionally in such numbers that when the trees have been shaken the beetles have fallen down like a shower of hail.

To kill these larvæ, water the grass in the autumn with one-tenth of gas-liquor to nine-tenths of water: it will do no mischief to the grass, but will extirpate these miners. When the gas-liquor cannot be obtained, employ strong salt-water. Mild weather should be taken advantage of in the spring for breaking up land thus affected, as at that time the larvæ are near the surface, and become an acceptable treat to the rooks, starlings, thrushes, blackbirds, robins, &c., and even sparrows have been known to gorge themselves with these larvæ so that they were unable to fly. In the absence of such useful birds, pigs will be of service in reducing the brood of maggots. Where the grass

is only partially spotted, it is very beneficial to strew potash, unslaked lime, or other alkalies, over the infested land before or after the winter season, which will restore the grass to vigour, and it is presumed will destroy the grubs. Heavy rolling has also been successfully resorted to with the view of settling the undermined turf. If it be necessary to destroy the beetles, a cloth should be spread under the clustered branches previous to shaking them, and, as the May-bug flies in the day, this operation must be performed early in the morning or in the evening.

33. THE MOLE-CRICKET—GRYLLOTALPA VULGARIS—

is sometimes abundant in marshes and damp pasture-lands, inhabiting also the banks of streams, ponds, &c. The history of this remarkable insect has been so fully given in a former report,* together with accurate descriptions and various suggested means for destroying it, that it will be unnecessary here to enter further on the subject.

GRASSHOPPERS and LOCUSTS.

These insects are distributed over every portion of the globe, and feed almost entirely on vegetable substances. Although their depredations in this country are not sensibly felt, it is evident to every one, by the incessant chirping of the grasshoppers in the autumn, that our fields, heaths, pasture-lands, and meadows must be swarming with them.

The female having deposited her clusters of eggs in the earth in August or September, they hatch early in the following spring, and produce minute creatures resembling the parents, except that they are destitute of wings. They at once commence feeding on the herbage, and as they grow they cast their skins six times, and gradually become exceedingly like the parents, but instead of wings they are only provided with two little flaps or rudiments of those organs. When they cast the last skin they become perfect grasshoppers, and then the wings are well developed in those species which are destined for flight.

In this country there are about twenty species, which vary greatly in their colour and markings; they belong to an ORDER called ORTHOPTERA, the FAMILY GRYLLIDÆ or LOCUSTIDÆ, and the GENUS LOCUSTA. Amongst the largest British species is one found in our marshes, named by Gmelin

34. LOCUSTA, or GRYLLUS FLAVIPES;

and occasionally the migratory locust (*Locusta migratoria*) visits this country in the autumn in small quantities, which are evidently

* Vol. vii. p. 432.

stragglers from some continental swarm. I dare not here venture on so extensive a subject as the history of this extraordinary plague.*

I shall merely add that birds feed upon the eggs of grasshoppers; swine will feed upon them; lizards destroy vast quantities; and Dr. Harris, of Massachusetts, states that "young turkeys, if allowed to go at large during the summer, derive nearly the whole of their subsistence from these insects."† There is another group of locusts, named *Acrida*,‡ which is distinguished from the true locust by its very long, slender horns, and the long exserted ovipositor of the females. There are ten species found in Great Britain, but only three or four of them inhabit our fields and meadows; and as they are nearly all uncommon, I shall here only allude to

35. Acrida viridissima (*Linn.*),

a fine green species frequently met with in our fields and marshes in the month of June.

Ants.

It is not within our province here to dilate upon the mischief which various species of ants commit in gardens, hot-houses, and even the dwelling-houses in the metropolis; we must not, however, pass them over unnoticed, as various species inhabit meadows and pasture-lands, not only disfiguring the surface, but absolutely affecting the value of grass-lands. Alexander says§—

"London clay is much better adapted for tillage than for pasturage, though there are some rich soils in pasture; but when they have been long without cultivation, there appears to be a favourable abode established for ants. We have seen many acres of this soil rendered scarcely worth 5s. per acre, by being covered with tumours and ant-hills; if these acres were cultivated as arable for five years and then laid to grass again, their value would be increased five-fold at the least."

Ants and their history are so well known that we need here only take a cursory view of them. They belong to the order Hymenoptera and the family Formicidæ. Like bees and wasps, each colony is composed of three different kinds of individuals, which are readily distinguished from each other, viz. males, females, and neuters. Both of the first two are winged, but after impregnation the female pulls off her wings and retires into the earth to deposit her eggs, amounting to four or five thousand. The neuters, which never have any wings, form by

* Most interesting accounts of the migratory locust will be found in Kirby and Spence's Introduction to Entomology; and a figure, descriptions, and an enumeration of the species are given in Curtis's Brit. Ent., fol. and pl. 608.

† Treatise on Insects injurious to Vegetation, p. 155.

‡ Curt. Brit. Ent., fol. and pl. 82.

§ Treatise on Soils, p. 44.

far the most numerous portion of each colony, being those ants which we see so busily employed in transporting seeds and all sorts of materials into their nests or ant-hills, and which seem to be never at rest. When the eggs hatch the larvæ or maggots are fed by these neuters, and, when they are full-grown, each spins an oval, tough, light-coloured case or cocoon, in which it changes to a pupa. These are erroneously termed "ants'-eggs," and in this particular they differ from another genus of ants which we shall notice hereafter.*

Eight or nine species of true ants comprised in the GENUS FORMICA have been found in this country, but the following only are connected with our present subject, viz.—

36. FORMICA SANGUINEA (*Latr.*).

Nests of this species are found on heaths in various parts of the south of England in July and August.

37. F. FLAVA (*Latr.*)—the Turf Ant—

is abundant on heaths and in meadows, where it forms its conical nest, and is found in the middle of April, the end of June, in July, and the beginning of September. The other GENUS of ants alluded to is named MYRMICA, of which there are seven or eight different kinds inhabiting Great Britain, but it is principally the following species which affect pasture-lands. Like the true ants, there are three different sexes, which undergo similar transformations, but it is singular that the larvæ or maggots spin no cocoons, and are consequently naked pupæ.

38. M. RUBRA (*Linn.*)—the Red Ant—

inhabits meadows, heaths, and banks, and is the principal agent in forming hillocks on pasture-lands.

39. M. PERELEGANS (*Curt.*).†

This species is rarely found on heaths, forming colonies under stones in July.

The following appear to me to be the simplest modes of ridding pasture-lands of ant-hills. Mr. Marshall, in his 'Rural Economy of Norfolk,' vol. ii. p. 10, says—

"In Norfolk they burn the ant-hills on commons, by which means they get good manure from the ashes, improve the pasturage, and rid themselves of a great nuisance. The plan is to cut up the ant-hills, and dry first the under and then the upper sides; they are then burned in a heap."

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* For figures and descriptions of the Horse Ant, *Formica rufa*, vide Curt. Brit. Ent., fol. and pl. 752.

† *Vide* Trans. Linn. Soc., vol. xxi. p. 211, for descriptions and figures of the species by the author.

It has been also recommended, in order "to destroy ant-hills in meadows," to

"divide them with a sharp spade into four quarters, pare off the turves, and fold them back; then dig out the contents of the ant-hill, throwing and spreading them about until a hollow be left, in which the rains will collect and, with the frost, destroy the broods; afterwards return the turves, which will be nearly flat, and make the surface green and even. This "gelding" is most beneficially done between Michaelmas and Christmas for the above reasons, and the grass will be established before the scorching heat of summer can affect it."—*Gard. Chron.*

The dew or earth worm, LUMBRICUS TERRESTRIS, is well deserving the farmer's notice, as it is not only universally distributed over his land, but is an active agent in pastures and meadows, in irrigating and manuring the soil, principally by its innumerable burrows and the fine earth which it casts out of them. Worms, like snails and slugs, are hermaphrodite, yet they pair and unite at the rings, embracing each other, the heads protruding. They so much resemble living muscle that a large fly named *Sarcophaga carnaria** (*Linn.*) has been known to lay its eggs on worms, which hatched and turned to maggots, feeding upon the worms as they would have done on the dead flesh of any animal, and changing, when full-grown, to pupæ, from which flies again emerged.

Worms lay eggs principally in the spring; they may be seen coiled up within the pellucid egg; and when the worms hatch they are about an inch long, but when full-grown they sometimes attain to an extraordinary size, being nearly a foot long, and as thick as a large swan's quill. It is almost needless to observe that worms are usually cylindrical, fleshy, composed of numerous rings, and of a rosy colour, but this varies to whitish or bluish tints in certain soils and localities. The anterior portion is of a livid colour, with a bluish or iridescent gloss, the head being very pointed, and the tail flattened.

A solution of salt and water will destroy worms, as will also corrosive sublimate, but one of the easiest and most efficacious modes of extirpating worms is to water the land with lime-water. It is, however, said that, while unslaked stone-lime is efficacious, *lime of chalk* has no effect upon them.

These Reports, which I have now brought to a close, will convince every one that the cultivator of the soil has multitudes of enemies to contend with—many of them difficult to detect, from

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* Gard. Chron., vol. vi. p. 275.

their minuteness and obscure economy. To make the farmer acquainted with the habits of these enemies, and enable him to recognise them under their different aspects of egg, caterpillar, pupa, and perfect insect, has been the object of these papers. The utility of this knowledge cannot be denied, and without ample descriptions and good figures it is impossible to identify such minute animals, which often resemble each other in an extraordinary manner, even where their food is of a totally different nature. The first step towards vanquishing an enemy is to ascertain correctly his habits; the next, to be so certain of his appearance as not to mistake one party for another; and a third and no less important object is to be well acquainted with our allies and friends: for want of this it has often happened within my own knowledge, and indeed it is a notorious fact, that the very insects ordained by the Creator to keep noxious species in check have been mistaken for the offenders; and thus the most serviceable auxiliaries have been persecuted, and even sacrificed to our ignorance of their deserts.

I cannot but hope that I have been permitted to lay a foundation towards a knowledge of the insects injurious to man, on which a more sound and perfect superstructure may be gradually raised, as materials are collected to increase and correct the mass of information which I have gathered together. As such observations are very tedious and difficult, the materials can be collected but slowly: if, however, every new discovery be faithfully and accurately recorded, it is impossible to calculate the happy results which may accrue towards averting the losses sustained from the attacks of insects. But I wish to impress in the strongest manner the absolute necessity of the agricultural observer, however talented he may be, calling in the aid of the scientific entomologist in his investigations, with the view of ascertaining the scientific name of the insect, and thus acquiring the means of referring to all that is known in relation to it; without this his discoveries will be but the "baseless fabric of a vision," and remain without "a local habitation and a name."

I will now bid farewell to my agricultural friends in the good old English phrase, "May God speed the plough!" I sincerely trust that my labours may tend not only to the instruction and to the benefit, but even to the amusement, of those engaged in the cultivation of the soil; and that the first step towards a correct knowledge of economic entomology may induce others to take up this important subject. After forty years' service in this labour of love, it is time for me to relinquish my pen and pencil, and release myself from my toil, which I cannot do better than in

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T D L

the words of the Mantuan bard, who delighted to sing of rural pursuits:—

"For, overlaboured with so long a course,
'Tis time to set at ease the smoking horse." *

EXPLANATION OF PLATE W.

Fig. 1. A head of *Trifolium pratense* (purple clover), divided to show five of the calyces eaten out by the maggots of *Apion apricans*. The orifices are indicated by brown spots.
2. A calyx detached, showing the hole eaten by the maggot.
3. The *larva*, or maggot, of *Apion apricans.*
4. The same magnified.
5. The *pupa*, or nymph, of ditto.
6. The same magnified.
7. *Apion apricans* or *flavifemoratum.*
8. The same magnified.
9. The mandible or jaw of *Apion frumentarium, Linn.*
10. The maxilla and palpus, or feeler, of ditto.
11. The chin, or mentum, and lip, &c., of ditto.
12. *Vicia sativa* (the vetch, or tare), infested by *Apion Pomonæ.*
l. The *larvæ*, or maggots, in sitû.
13. A pod of the vetch opened, exhibiting the perforated seeds.
14. The *larva* of *Apion pomonæ (?)*
15. The same magnified.
16. *Apion pomonæ.*
17. The same flying and magnified.
18. Head of the male.
19. Head of the female.
20. The horn, or antenna.
21. A leg.
22. A calyx of *Vicia sepium* (?) which contained several larvæ of some species of *Apion.*
23. One of the *larvæ*, removed from the calyx.
24. The same magnified.
25. *Chrysomela (Phædon) polygoni.*
26. The same magnified.
27. The labrum, or upper lip.
28. One of the mandibles, or jaws.
29. One of the maxillæ, with the palpus, or feeler.
30. The labium, or under lip, with the two palpi, or feelers.
31. The antenna, or horn.
32. One of the legs.

Obs.—All the figures are drawn from nature.

Belitha Villas, Barnsbury Park, May, 1857.

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* "Sed nos immensum spatiis confecimus æquor:
Et jam tempus equûm fumantia solvere colla."
Virg. Georg. ii. 541-2.

V.—*Farm Roads on Strong Soils.*

By J. Bailey Denton.

Prize Essay.

As the practice of draining extends the importance of good internal roads on clay farms will become daily more manifest. The productive capabilities of clay soils being developed by drainage, it will remain only to attract to those soils occupiers of intelligence and capital by works of accommodation by which their cultivation may be properly conducted; and it matters not whether we regard the possession of hard roads as a means of economizing labour and time in the use of horses and men, or as a means of lessening the wear and tear of carts and harness, the advantage of having such roads in the place of bottomless rut-tracks is so manifest to every one that it requires no figures to prove nor arguments to enforce it. We can only wonder how an improvement so generally required has been so much neglected in districts destined to become, as the late Professor Johnston has declared, "the richest corn-bearing districts in the kingdom." Improvements, however, which necessitate a considerable outlay, are ordinarily deferred until obligations enforce their execution, and road-making in absorbent and retentive clay soils is doubtless an expensive process; for true economy in this important art admits of no compromise with those fundamental principles by which an even hardness of surface is rendered durable without a waste of material. Beyond the consideration of expense, however, there is still a question unsolved, which causes the work to be delayed, *i.e.* whether the making of farm roads should be deemed the work of the occupier or of the owner? and until this question be practically answered by the owner taking upon himself a work so essentially an element of value in fixing the rent of land, it is not likely that agriculturists will gain any extended experience themselves, nor profit very largely by the knowledge of practical road engineers.

It can readily be understood that the owners of entailed property should be indisposed to expend large sums of money in such costly improvements, when it is improbable that they can live to see the outlay liquidated by the increased rents which should naturally follow; but if this be admitted as an impediment with respect to owners with limited interests, how much more strongly does it apply to occupiers at will, who may have nicely balanced their capital to the number of acres they purpose to cultivate, and who cannot spare any portion of that capital for permanent works of improvement!

This observation may apply to all descriptions of permanent

works, but it is peculiarly applicable to the making of roads through clay districts, in which it is most frequently found that materials are scarce, and the cost of maintenance (unquestionably the tenant's duty) therefore very heavy. It would appear only fair and reasonable that neither the owner for life nor the tenant at will should supply the capital required for the making of roads. In road-making, as in draining, and other permanent improvements, the outlay should be met by means of borrowed capital charged on the improved lands and repayable by instalments in a given number of years.

It is an axiom with engineers that roads should be so substantially constructed and metalled that the cost of their maintenance shall be reduced to a minimum, *i. e.* to just such an amount as will simply replace the current loss of materials by the wear and tear of traffic.

But with respect to internal farm roads, it has been urged with some propriety that it is not expedient to apply this rule with the same arbitrary bearing as to public roads, and the reason assigned is, that the preservation of the former is solely dependent on those individual tenants who use them, and who are directly bound to maintain them, whereas in the case of turnpike and parish roads, as the public use them without distinction, there are no direct influences in force to lead to carefulness and timely reparation.

It has been therefore urged that if less metalling were used in the making of farm roads than the engineer would prescribe, the tenant would be more careful when using not to abuse them, knowing that the burden of maintenance will fall directly and wholly upon himself.

This argument, if tenable at all, can only extend, however, to the quantity and description of material used. The same care in forming and draining is requisite in all roads, whether private or public, and when considered with regard to materials, the argument will have little weight where stone or gravel is handy, cheap, and good, though it may, and will, have influence in localities where the other extremes of distance, price, and quality prevail.

Admitting the force of expediency in cases where materials are extremely costly, it may be useful to illustrate its influence by reference to two instances which have recently come within the experience of the writer. The first was the case of a farm-road in the coalmeasures clay district of Cheshire, and the second (also a farm-road) on the lias, in the Vale of Belvoir. In the first case unexceptionable material was obtained from the neighbouring millstone-grit rock and delivered on the road at an average cost of 2*s.* 6*d.* per cubic yard. In the second case, as no

suitable stone or gravel was to be got in the locality, the lias clay was burnt into ballast and used for the lower stratum or foundation at a cost of 2*s.* 6*d.* per cubic yard, while the upper stratum or covering was of Trent-gravel, and cost 8*s.* per cubic yard.

Now it is easy to understand by a comparison of these figures that in the first case sound economy was best promoted by putting on an *extra* depth of material, whereby the cost of future maintenance would be reduced to a minimum, whereas in the second case, it was equally discreet to limit the expenditure in covering-material to an amount just sufficient to make a hard road, but which would oblige the tenant to observe considerable watchfulness, and to expend annually an appreciable sum to maintain it in good condition.

In road-making, as already premised, certain fixed rules or principles of formation or construction should be observed in all localities, and these it is intended to particularize in the remarks about to be offered under the head of "*Fundamental Principles.*" Those modifications which are due to different localities and soils will be subsequently explained under the head of "*Local Modifications,*" but they apply simply to the description and quantity of materials used, and do not affect the primary rules of formation.

Fundamental Principles.

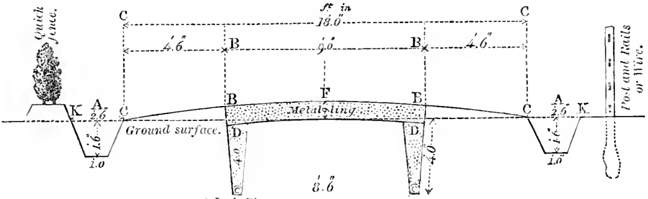
So many circumstances are generally found to exist in a farm which serve to predetermine the course of a required road through it, that it would answer no useful purpose to expatiate at any length on the *longitudinal formation or section* of roads. The nearer all roads approach to a straight and level line the better. A straight line, however, unless it be associated with a level profile may easily lose the advantage of being the shortest distance between two points. Mr. Macneill's experiments on draught show that the actual saving in power by the adoption of a course of road with inclinations of 1 in 40 is 20 per cent. over one with inclinations of 1 in 20, all other considerations being equal; and these figures, when reduced to money value, show that if the cost of carrying a ton of manure or corn along a road with inclinations of 1 in 40 is 8*d.*, the cost of carrying the same load along a road with inclinations of 1 in 20 is 10*d.*

The difference of 2*d.* per ton in the resistance thus arising from gravity alone, swells into a considerable item when multiplied by the numerous tons of corn, straw, hay, and manure, of which the internal traffic of a farm consists, and it sufficiently shows the advantage of adopting gradients as flat as circumstances will permit in all roads not necessarily fixed by the situation of the

homestead, the shape of the farm, its divisional fields, and the form and physical condition of its surface and soils.

With respect to the transverse formation or section of roads much may be said which will be found applicable to all roads, but more especially to those in clay districts. In fact, to illustrate in any general terms the art of making farm-roads in clay districts, it would appear only necessary to exhibit the *transverse or cross section*, for, as already stated, the longitudinal section or profile will, in nearly every case, have been determined beforehand by local features. The judgment of the road-maker then will be confined to securing an unyielding hardness of surface with the least amount of material,—an even smoothness of surface with the least amount of labour,—and the utmost durability consistent with the object in view.

The following section and rules will indicate how these objects may be attained.



2-Inch Pipe.

1st. The road should be perfectly drained by means of surface ditches, as A A, on each side of the formation, and of under-drains, as D D, on each side of the metalling.

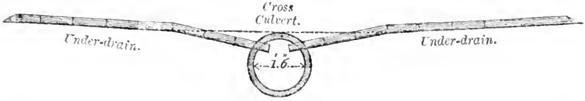
2nd. The formation should be 18 feet wide, at least, between the inner edges of the surface ditches, *i. e.* from C to C.

3rd. The surface ditches A A should be at least 18 inches deep, with good and sufficient batter or side slopes. They should have sufficient fall towards existing watercourses to discharge freely all water that may run into them, and pipe-culverts protected by end gratings should be provided at all gateways opening to the road.

4th. The metalling should be 9 feet wide at least, *i. e.* from B to B.

5th. The under-drains D D should be dug 4 feet deep at least, on each side of the metalling, laid with 2-inch pipes, and connected with the culverts or drains crossing the road at every fence and every hollow in the ground, and these cross culverts or drains should be laid so low in connection with existing ditches (to be deepened if necessary for the purpose), that the crown of the

cross culvert or drain shall be no higher than the bottom of the under-drains, thus—



At the ends of each cross culvert there should be an iron grating to prevent the passage of vermin. The under-drains should be carefully filled to the height of the metal bed with the earth taken out of the drains.

6th. The surface of the road, for its entire breadth of 18 feet or more from C to C, should be raised above the ground surface in a convex shape.

7th. The height of the centre of the road above the ground surface should be as near as possible the thickness of the metalling, whatever it be. It is necessary, however, that the ground or base upon which the metalling is placed should be perfectly solid, and, if possible, unbroken. It should be convex and accord in form with the intended convex shape of the surface of the road itself.

8th. The metalling may consist of two or more layers or strata, which, together, should be 9 inches deep at least. This depth will suffice where the materials are of the best sort, but they should be proportionately deeper in cases where the materials are softer and less durable.

9th. The metalling should be of uniform depth for its entire width.

10th. The under stratum or foundation of metalling may consist of any durable porous or non-absorbent material, of the depth of 4½ inches at least. It may be judiciously increased where the material required for the upper stratum or covering is very costly, when the depth of the covering may be reduced accordingly. It is not essential that the material for the foundation shall be of uniform size as long as it lies compact, is well bonded, and its surface is even and regular to receive the upper stratum.

11th. The upper stratum or covering should be of the best description of clean stone, or sifted gravel, or pebbles, the country will afford. If gravel, it should be screened to get rid of sand and dirt, and the larger stones should be broken, so that no particle shall be left on the road exceeding 2½ inches in the longest diagonal line. The depth should be 4½ inches, and should, if possible, be placed on the road in two courses.

12th. The side spaces (4 feet 6 inches each at least), *i. e.* from B to C, should be carefully finished off in close conformity with

the metalling. The fall thus given from the centre to the sides of the road will ensure a perfect drainage of the surface into the side ditches. The spaces should be seeded and rolled, or beaten down firmly.

13th. There should be no fence that will throw a shadow on the road.

14th. The road, after its completion, should be most rigidly maintained in its convex form; any unevenness should be overcome by the rake, and all ruts and hollows should be kept filled in at once with fresh material properly broken to the same size as the original metalling, and the side ditches should be kept open and free to discharge the water flowing into them. No water should be allowed to stand on either the metalling or the side spaces, but the water should be got rid of, *not by making grips or channels into the side ditches, but by filling up hollows and ruts, and keeping the whole in its original form.*

It will be observed that in these rules very great stress has been laid upon both surface and under draining. All engineers have acknowledged the advantage of rendering roads dry and unyielding, and considerable attention has been paid to surface-draining, but the importance of under-draining roads by means of longitudinal pipe drains, laid sufficiently deep and near each other to remove sock or bottom water, and overcome as far as possible capillary attraction and suction in the soil, has been overlooked until very recently. A shallow centre drain, called a mitre drain, was often adopted with good effect, but it failed to render the subsoil dry, and increased the cost of the road very considerably.

There is but little doubt, however, that the advantages arising from the act of adequately deep under-draining, both in economising materials and in reducing the cost of maintenance, surpass any single appliance of either Telford or MacAdam in the practice of road-making. The effect of deep under-drains on each side of the metalling is to render the mass of soil between them perfectly solid and inflexible, so that any metalling, let it be either loose gravel or a close pavement, rides upon it without sinking into it.

The solid and firm base thus obtained is equivalent to at least one-fourth of the metalling ordinarily put on roads. That proportion which is so frequently sunk and buried in the clay base is saved, and it has been found that roads carefully formed and under-drained, with 9 inches of metalling, will better preserve their shape and a hard and firm surface, than roads with 12 inches of metalling without under-draining.

The practice too of laying faggots as a foundation is superseded by under-draining, except in cases of peat-bogs and deep spongy soils, where a layer of faggots is essential as a platform

for the materials. In dealing with homogeneous clays the use of faggots is much to be reprehended. Their elasticity keeps the base of the road in a constant fret and soft state, causing the clay to rise and the metalling to sink between the branches and twigs of which the faggots are composed.

It is quite unnecessary to enforce the advantage of surface-draining in the maintenance of roads. Practical men all agree in the importance of keeping the surface free from standing water, although the means adopted for the purpose are different. In France, Switzerland, and Northern Italy, the best public roads are made of a convex shape, and are most rigidly preserved in that shape. Perhaps the most remarkable feature in Napoleon's great roads is the perfection of their surface-drainage. In great Britain it would appear that several engineers of celebrity have advocated the adoption of roads transversely flat as the better suited for quick traffic, but Telford always adhered to the convex shape, and some of our best turnpike roads afford evidence of his sagacity in the art of road-making. Under any circumstances the convex shape will be deemed preferable for farm-roads in consequence of a space being necessary on each side of the metalling, which it is most desirable shall be kept hard and dry for occasional use when carts and waggons meet, and this object cannot be gained without there is a good inclination from the centre of the road to the side ditches.

It is too frequently the habit to treat these side spaces as so much waste on which to collect road scrapings, manure, soil, and so forth, and to place there the materials for the repairs until such accumulations raise the sides higher than the metalled centre, and so convert the road into a trough—the very opposite of what was intended by its convex construction.

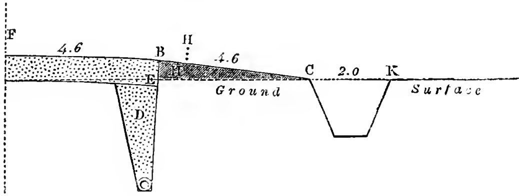
The whole formation (from C to C—see fig., p. 85) should stand in bold relief above the adjacent ground-surface, in order that both sun and wind may have uninterrupted effect in drying the surface.

For this reason no fence other than an open wire or post-and-rail fence should be allowed to stand on the sunny side of an internal farm-road. As the cost of making a road will very materially depend on the care with which the under-draining is perfected, so will the cost of maintaining it depend upon the degree of care with which its convexity is kept up and means adopted for admitting to its entire breadth the full influence of sun and air.

With these general remarks we will proceed to detail the mode of operating by which the foregoing principles may be brought to bear.

Having set out the course of the intended road by a centre line of stakes F, the distances from that line to the edges of the metalling B and the side ditches C K should be carefully

marked out. The cross culvert and cross under-drains should then be fixed and constructed, or laid; the floor or invert of every culvert or drain should be 5 feet below the surface of the



road when finished, in order that the longitudinal drains under the roadway be at least 4 feet deep. The ditches or watercourses with which the culverts communicate should be cleared out or deepened to a sufficient depth to free the culverts and drains of standing water. The side ditches C K, and under-drains D, should then be dug. The earth thrown out of the side ditches will serve to form the raised side spaces of the road H, care being taken that a good shoulder be formed at B to receive the metalling.

The earth thrown out of the under-drain D should be returned into it after the pipes are laid and closely trodden in. If a part of the metalling used for the foundation be mixed with it the base of the road will be kept drier *during construction.* No advantage is gained by the mixture after completion.

In shaping the base to a convex form for the metalling a small quantity of soil will have to be taken off the sides at E, and this soil, with the surplus which will remain out of the under-drains, will serve to fill up hollows and irregularities in the formation level. Where high-backed lands are crossed the labour and cost of formation will be considerably increased.

The approximate cost of forming roads for metalling per chain will be as follows:—

	s.	*d.*
Digging *side ditches*, 18 inches deep, 30 inches at top, and 12 inches at bottom, say 13 cubic yards per chain, at 3*d.* per yard	3	3
Digging and filling *under-drains*, 4 feet deep, 8 rods per chain, at 6½*d.* per rod	4	4
Pipes for same, 135 per chain, at 20*s.* per 1000	2	9
Laying and treading in	0	6
Forming base for metalling, shifting earth, levelling, and finishing side spaces, seeding same, &c.	3	9
	14	7
Add for proportion of culverts and contingencies 10 per cent.	1	5
Total cost of formation per chain	16	0

Local Modifications.

Commencing with those clay districts which belong to the more recent geological formations,—the unstratified series superincumbent in the chalk,—and which include the *London clay*, the *Weald clay*, and the *clays of the Bagshot sand*, it will be found that gravel is of very frequent occurrence, although a substitute has frequently to be found when we advance far into the wide breadths of the London and Weald clays.

In those places where gravel exists near at hand it is used in an unsifted state for the foundation or substratum, and costs on an average (with a bearing of 2 yards of soil) 5½*d.* per cubic yard clamped at the pit ready for carting. It is sifted and broken to a proper size for the covering or upper stratum for 5*d.* more, making 10½*d.* per yard. These prices are quoted in reference to labour only.

In places near the margin of the London clay, recourse is often had to the underlying chalk for the foundation, as a cheaper material than gravel; sometimes it is fetched from a neighbouring pit, and sometimes raised by means of shafts or wells sunk through the clay into the chalk below.

Digging chalk with a bearing not exceeding 1½ yard, and clamping it at the pit ready for carting, will average 4½*d.* per cubic yard, and the cost of carting it from the pit by road will be from 10*d.* to 1*s.* per cubic yard per mile. The weight of a cubic yard is about 26 cwt. The cost of raising chalk by shaft and buckets will be 8*d.* per cubic yard if the depth does not exceed 20 feet, to which 1*d.* per cubic yard must be added for every additional yard of depth. Flints will be charged for extra, at 1*s.* 3*d.* per cubic yard. The cost of carting will in this case average 1*s.* per cubic yard in consequence of the extra labour of moving over fields in the place of hard roads. The objection to the use of chalk is that frost acts very quickly upon it. If not thickly and uniformly covered with gravel or stone three or four days' sharp frost will greatly injure the best-formed roads.

Where neither gravel nor chalk can be got readily the clay subsoil itself may sometimes be burnt into ballast, to be used as the foundation or substratum.

The cost of digging and wheeling the clay to the ballast heap will depend upon the distance between the place from whence the clay is obtained and the site selected for burning it, which should be fixed with reference to the distance which the ballast will have to be carted to and along the road. It sometimes happens that the clay may be got out of the bed of the road itself at some one or more prominences or hills in its course, which it would be better to remove or lower. Every 50 yards run for the barrows between the clay bed and the ballast heap will add 1*d.* per cubic

yard to the cost of the clay, and every half-mile of carting will add 6*d.* per cubic yard to the cost of moving the ballast, which, however, may be somewhat increased or reduced by the position of the heap in necessitating an uphill or downhill delivery. With a run not exceeding 50 yards the average cost of digging the clay (with a bearing of 4 feet of soil upon it) and getting it to the heap will be 6½*d.* per cubic yard. This price will change with the character of the clay, the depth of bearing, and the length of the run.

The cost of burning the clay into ballast will depend upon the price of coal delivered at the heap, the quality of the clay for burning, and very much upon the experience of the burner. A man thoroughly acquainted with the process of burning will make a ton of coals—which, to be suitable, should be small, but good in quality, like those the blacksmiths use—burn from 16 to 20 cubic yards of ballast, according to the nature of the clay. The average cost of burning, including coal, may be taken at 1*s.* 3*d.* per cubic yard. The purer the clay the better the ballast it makes. A very superior description of ballast, however, is made from diluvial clay at the mouths of rivers, in which there is a proportion of vegetable fibre, and from the gault of the greensand, in which there is a considerable proportion of lime, which foreign elements assist the vitrification by admitting the fire through the clay lumps. In much of the surface clays overlying the chalk there is a large proportion of sand—seldom less than 12 per cent.—which is a great bar to the making of good ballast, but when the London clay, *in situ*, is penetrated, the best of ballast is made from it. A yard of ballast will weigh from 17 to 18 cwt. —a reduction in weight when compared to gravel, chalk, or stone, which speaks much in its favour.

The approximate cost per chain of the several descriptions of roads indicated as suitable to the clay districts overlying the chalk will be as follows:—

No. 1. With sifted gravel on a foundation of unsifted gravel, charging nothing for the gravel in the bed.

	£.	s.	d.
Formation (as detailed)	0	16	0
Foundation or lower stratum of unsifted gravel, 4½ inches deep, 8¼ cubic yards, at 5½*d.* per cubic yard, digging and clamping	0	3	9
Filling, at 1½*d.* per yard	0	1	0
Carting an average lead of 1½ miles, at 10*d.* per yard per mile	0	10	4
Spreading, at 1*d.* per yard	0	0	8½
Covering or upper stratum of sifted gravel, 4½ inches deep, 8¼ yards, at 10½*d.* per yard	0	7	2½
Filling, carting, and spreading, as above	0	12	0½
Finishing, &c., at 2*d.* per yard of covering	0	1	4½
Total cost per chain	2	12	5

No. 2. With sifted gravel on a foundation of chalk, charging nothing for either the gravel or chalk in the bed.

	£.	s.	d.
Formation (as detailed)	0	16	0
Foundation, 8¼ cubic yards of chalk, at 6*d.* per yard ..	0	4	1½
Filling, at 1½*d.*; carting 1 mile, at 1*s.*; and spreading, 1*d.* per yard	0	10	0
Covering as in No. 1	0	19	3
Finishing as in No. 1	0	1	4½
Total cost per chain	2	10	9

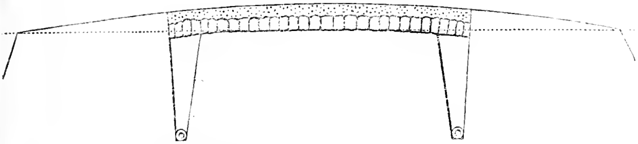
No. 3. With sifted gravel on a foundation of burnt clay ballast, charging nothing for gravel nor clay in the bed.

	£.	s.	d.
Formation (as detailed)	0	16	0
Foundation, 8¼ cubic yards of burnt clay ballast, at 1*s.* 10½*d.* per yard	0	15	5
Filling, at 1½*d.*; carting ½ mile, at 9*d.* per yard per mile; and spreading, at 1*d.*	0	4	10
Covering as in No. 1, excepting that the carting will be ½ mile more, *i.e.* 2 miles	1	2	8½
Finishing as in No. 1	0	1	4½
Total cost per chain	3	0	4

In the more central clay districts of the greensand, oolite, and lias formations, within which the *Gault, Oxford*, and *Lias* clays cover so large a space, gravel is less frequent. In some situations, however, drifted gravel is found in plenty, and of such superior quality that it may be used with impunity without sifting (see instance No. 4).

The cost of carting this gravel is proportionately higher, as the farm upon which it is wanted recedes from the margin of the clay where the drifted beds are mostly found.

The writer is now having gravel dug and clamped in a pit two miles south-west of Peterborough, at 4*d.* per cubic yard, and sifted for 4*d.* more, making the cost of sifted gravel 8*d.* per cubic yard. In some places, where gravel is beyond the bounds of moderate cost, the oolite and lias rocks may be brought advantageously into competition with it (see instance No. 5). These layers of rock may be quarried, broken to two sizes for foundation and covering, and clamped ready for carting, at an average cost of 1*s.* 3*d.* per cubic yard. But the best description of road, and in the end the cheapest that can be made in such places, will be found to be by the use of the native rock as a paving or pitching on the Telford principle, with a covering of sifted gravel. The rock should be quarried for the purpose and laid thus—



It is not necessary to have the pieces uniform in size so long as the upper surface is regular and the whole firmly set. The hand-laying of the stones will cost, on an average, three farthings per square yard (see instance No. 6).

Where neither native gravel nor rock is to be obtained, metalling from a distance has to be imported by canal or railway for the covering, and the total cost is much increased thereby. The writer has constructed roads on the Oxford and lias clays, of which the cost per chain has varied from 2*l.* 8*s.* 4*d.* to 5*l.* 5*s.* 6*d.* In the first instance clean native gravel, of excellent quality, and which did not require sifting, was wholly used. In the latter the metalling for the covering had to be obtained from a considerable distance by canal, with a heavy cartage from the canal to the road: burnt clay was used for the foundation. This substitute for natural metalling is daily coming more and more into use throughout the Gault, the Oxford, and the Lias clay districts. In these clays the proportion of sand is generally less than in others, and therefore a superior description of ballast is made. Coals, too, are cheaper in the Midland and North-Eastern counties than in the South-Eastern counties, and this fact has had its influence in bringing burnt ballast more into use, and in making its manufacture better understood.

The approximate cost per chain of the several descriptions of roads suitable to the clay districts of the greensand, the oolitic, and lias formations will be as follows:—

No. 4. With unsifted gravel wholly.

	£.	s.	d.
Formation (as detailed)	0	16	0
Metalling, 9 inches deep, $16\frac{1}{2}$ cubic yards, at $4\frac{1}{2}d.$ per yard; digging and clamping	0	6	2
Filling, at $1\frac{1}{2}d.$ per yard	0	2	1
Carting $1\frac{1}{2}$ miles, at 10*d.* per yard per mile	1	0	8
Spreading, breaking, and finishing, at $2\frac{1}{2}d.$ per yard ..	0	3	5
Total cost per chain	2	8	4

No. 5. With broken oolitic or lias rock wholly.

	£.	s.	d.
Formation (as detailed)	0	16	0
Metalling, 9 inches deep, $16\frac{1}{2}$ cubic yards, at 1*s.* 3*d.* per yard; quarrying, breaking, and clamping	1	0	8
Filling, carting, spreading, and finishing, as No. 4	1	6	2
Total cost per chain	3	2	10

No. 6. With sifted gravel (one-third) on a paving of oolitic or lias rock (two-thirds).

	£.	s.	d.
Formation (as detailed)	0	16	0
Foundation, 6 inches deep, 11 yards, at 1*s*. 4*d*. per yard; quarrying measured on the road	0	14	8
Filling, at 1½ *l*., and carting 1½ miles, at 1*s*. 1*d*. per cubic yard per mile	0	19	3
Laying pavement, &c., ¾*d*. per square yard	0	4	1½
Hammering surface regular, ½*d*. per square yard	0	2	9
Covering, 3 inches deep, 5½ yards, at 10½*l*. per yard ..	0	4	10
Filling, carting, and spreading	0	9	7½
Finishing, 2*d*. per yard	0	1	4½
Total cost per chain	3	12	7½

No. 7. With sifted gravel from a distance on a foundation of burnt clay ballast.

	£.	s.	d.
Formation (as detailed)	0	16	0
Foundation as in No. 3	1	1	3½
Covering, 8¼ yards of imported gravel, say at 5*s*. per yard, delivered at canal wharf, within 1½ mile of road	2	1	3
Filling, carting, and spreading, as in No. 1	0	12	0½
Finishing, at 2*d*. per yard	0	1	4½
Total cost per chain	4	11	11½

No. 8. The foundation of roads of much traffic may be advantageously made of concrete—of lias lime and gravel—as adopted by the Romans in their military ways through France.

The proportion of gravel to lime should be as 4 of gravel to 1 of lime. The concrete should be made on the bed of the road, after it is prepared for the metalling. Great care should be taken when the water is added that every particle of the lime is properly slaked and saturated.

The layer of concrete need not be deeper than four inches, with a covering of gravel of the same depth; but the latter should be put on, if possible, in two courses, the first before the concrete is set hard, in order that the gravel may penetrate it. The concrete then forms a matrix, from which the gravel cannot be shifted. Acceptable concrete may be made with well-burnt clay ballast in lieu of gravel.

The cost of the concrete will necessarily vary with the price of lime and gravel. About 5½ bushels of good lias lime will suffice for three cubic yards of gravel. Assuming that the lime delivered costs 7*d*. per bushel, and the gravel 2*s*. 6*d*. per yard, the cost of four yards will be 10*s*. 8½*d*.; thus—

	s.	d.
Lime	3	2½
Gravel	7	6
	¼) 10	8½
	2	8
Add labour of mixing and laying	2	6
Cost of concrete per cubic yard	5	2

Upon these figures the cost of the road per chain will be—

	£.	s.	d.
Formation (as detailed)	0	16	0
Foundation, 4 inches of concrete, 7⅓ yards, at 5*s.* 2*d.* per yard, including laying	1	17	10
Covering same depth, 7⅓ yards, at 2*s.* 6*d.* per yard ..	0	18	4
Spreading	0	0	7½
Finishing	0	1	2½
Total cost per chain	3	14	0

No. 9. While treating of the clay districts of the oolitic formation, it may be desirable to refer to a suggestion made by the writer in a paper read at the Central Farmer's Club in June, 1855, for the adoption of the perforated bricks made by Beart's patent, as a foundation for roads in the fen districts overlying the Oxford clay. It will take 2376 bricks laid flat to form the foundation of roads, with 9 feet metalling, and the approximate cost will be—

	£.	s.	d.
Formation, the cost of the under-drains being slightly reduced	0	15	0
Foundation, 2376 bricks, and carriage, at 20*s.* per 1000	2	7	6
Laying same	0	3	10½
Covering of sifted gravel imported, 6 inches deep, 11 yards, at 5*s.* per yard delivered .. .. .. : ..	2	15	0
Spreading and finishing	0	2	9
Total cost per chain	6	4	1½

The advantage of perforated bricks will be found to be twofold: first, in constituting a ready means of draining, and next, in affording a matrix to fix the superincumbent gravel.

In the clay districts of the *two red sandstones* and of the *coal-measures* which succeed the lias, several of the descriptions of roads already given will be found available.

The red sandstone rock makes a very good paving for, or foundation of roads, if properly laid on the Telford principle. It should be well covered to prevent the sandstone being ground to powder by the friction of traffic. It can be quarried to suitable size at 1*s.* 3*d.* per cubic yard. The conglomerate of the red sandstone formation also makes a good foundation, and the pebbles, when broken, are an excellent covering; but materials from a

distance will often be required when the pebbles or native gravel are not available as a covering. The writer has paid as much as 10*s.* a yard for granite for this purpose in one instance, which brought the total cost of the road to above 6*l.* per chain. Broken granite will weigh double the weight of gravel, and on that account alone is very expensive.

The limestones which adjoin the red sandstones also afford an excellent foundation under either gravel, granite, gritstone, or any other metalling not affected by frost. Both the magnesian and mountain limestones are, however, often wholly used and with superior effect; in fact the limestones of the lower secondary and transition strata are hard, and an excellent material of themselves, not being liable to decay by the effects of frost as the lias and oolitic beds.

The millstone grit which borders on the coal-measures clay can be quarried, broken in two sizes, and clamped ready for carting, at an average cost of 1*s.* 6d. per cubic yard. Good roads have been made with a foundation of this rock, broken to the size of 3½ inches, and covered by an equal quantity broken to the smaller size of 2½ inches, at the cost of 3*l.* 10*s.* per chain; the carting being 1½ mile from the quarry to the road.

Having referred to the various clay beds in the order of their geological succession, it should be observed in conclusion that the prices which have been given in the foregoing paper are only approximate prices.

It has been assumed that the landowner promoting the improvement finds the material in its unprepared state, where it exists on the estate. The object in setting forth these figures is to represent comparative rather than actual cost. All practised road-makers know that peculiarities attend every locality and every stratum of the earth's crust, and that it would be impossible to quote figures which could be accepted as appropriate and strictly accurate without special examination.

52, *Parliament Street, Westminster, March,* 1857.

The foregoing excellent and practical essay on the construction of roads on retentive soils will probably rank among the very best that have hitherto appeared on the art of roadmaking. The great cost, however, of a thoroughly well-made road, such as is here described, will effectually deter both landlord and tenant from roadmaking on such a scale, except in cases where the traffic is considerable. But every clay-land farmer is deeply interested in having practicable roads at all seasons between the different portions of his farm, and I am therefore anxious to point out to him that the principles here laid down admit of a much wider application than might at first sight appear. The

two points to which primary importance is very properly attached in this essay are *good form* and *efficient drainage.* Both have the same object in view—viz. to keep the road free from superfluous moisture. Let every roadmaker then bear constantly in mind that his main object is to *make his road dry.* The first step is to underdrain it. An ordinary farm-road across fields will not require more than one good tile-drain, 4 feet deep. If the road follow a line of fence, the drain should be laid along that side which is farthest from the hedge. If the road leave the fence, the drain should be laid along that side on which the land is highest. If this be done at the time when the general drainage of the farm is executed, it will in most cases be practicable so to lay out the drains as to add little, if at all, to the length of drain that would otherwise be required; but if the land is already drained, and the roads have been neglected, so that it becomes necessary to lay a new drain the whole length of the road, no kind of drainage can be executed with more certainty of a good return than this. It will not come in the shape of increased receipts; but diminished expenses are equally efficacious in improving the balance-sheet at the end of the year. This under-draining is, fortunately, not a very heavy operation, as the length of drain required for a mile of road of this description scarcely exceeds what would be required to drain $2\frac{1}{2}$ acres of land at 7 yards apart.

Having thus dried the land *under* the road, the next step must be to prevent the water from remaining *upon* the road, and for this purpose it is requisite both that its surface should be of a rounded form so as to throw off the rain as it falls, and also that the whole road should be above the level of the adjoining land, and thus afford an easy escape for the water at all points.

If the foregoing instructions be carefully carried out, the newly-constructed road will be complete as to its drainage, and the only other essential is that the surface should be covered with such materials as will resist the wear and tear of traffic, and preserve the form upon which its maintenance depends. In this the farmer must be guided very much by the class of road and the use he makes of it. Should it only lead to a few fields, and therefore not be much used except at particular seasons, a good deal may be done by merely throwing up the sides in dry weather, so as to raise the road above the level of the adjoining land. He must also as much as possible select frost or dry weather for carting out manure, and, if obliged occasionally to do some heavy work in wet weather, the first opportunity must be taken of having the ruts thoroughly put in and the rounded form of the road restored. Especial care should also be taken to make the gateways a trifle higher than the rest of the road, as from stock collecting around the gates, and other minor causes, there is a

tendency to wear into a hole at the gate, and when once the water lodges the evil soon increases. The mischief frequently takes its rise from the gate-posts being set too low, so that to enable the gate to shut readily the road is lowered precisely at the place where it should be, if anything, rather higher than elsewhere.

There is another class of road, which is intermediate between the mere cart-track and the regular public road, such as the road from the homestead to the nearest highway, which must be traversed by heavy loads at all seasons. In dealing with this class the nearer the roadmaker can approach to the directions given in this essay the greater will be the satisfaction of the farmer himself, his men, and his horses; but as the outlay is confessedly heavy, he may do a good deal in the course of years by minor improvements, if rightly done. Under-drainage is in all cases imperative. All outlay is wasted so long as the road rests on a wet bed; but having done this, and thrown it into a rounded form in dry weather, almost any porous material will considerably improve it. Sand, if close at hand, will do much, also cinders, brick rubbish, or burnt clay, as suggested in the essay; and when these have been applied a very thin coating of gravel or broken stone will have a great effect. It should, however, be never forgotten that one load of metal properly applied—*i.e.* well broken and kept to its proper form—will do more towards making a good road than double the quantity put in rough and allowed to get into ruts.

H. S. THOMPSON.

VI.—*Cultivation of Early Potatoes.* By the Rev. E. F. MANBY.

So much has been said upon the cultivation of the potato, so many causes assigned to the disease with which of late years it has been more or less affected, and so many remedies prescribed, that we feel some apology is due to our readers in bringing the subject again before them.

We should not, however, venture to intrude upon their attention had we not reason to suppose that we could lay before them some information which might prove to be not entirely void of interest.

Thus far we can promise—to describe a system of cultivation which the experience of many years has proved to be attended with great success and profit, and which we believe to be at present practised only by a few growers, and confined to a limited district.

"Poulton" or "Morecombe" potatoes have now become so

celebrated for their excellence that we purpose giving an account of the mode of cultivation there pursued.

Poulton, or, as it is now called by the more dignified name of Morecombe, forms part of a township in the parish of Lancaster, adjacent to the shore of Morecombe Bay. The soil, at least that most favourable to the growth of the potato, is a *sandy* loam upon a subsoil of gravel. There are other soils likewise on which they are cultivated—moss upon clay, and calcareous loams—but these latter are not considered equal to the first mentioned, nevertheless they are useful for raising seed, a change of soil being most beneficial.

It will scarcely be credited that on the same land for a period of twenty and more years in succession crops of potatoes have been taken. Indeed, previous to the disease it was customary to obtain two crops of potatoes the same year from the same ground; the first of which was taken up in June, and the second in September. But since then it has been the usual practice to transplant swedes or mangold-wurtzel, and of late even to sow the former; though many growers will sow Dale's Hybrids, Yellow Bullocks, and other kinds of quick-growing turnips. The produce of these second crops will average about 15 tons to the acre. In fact, we have observed but little difference between a second crop of turnips here and first crops elsewhere.

But it may be objected that this is not farming, but gardening: —we beg to reply that it is cultivating the soil; and that as long as a profitable, paying, produce can be obtained from the land by cultivation, it matters not what name you give it.

Again, it may be said that, after all, such a system can never be carried out on a large scale. We answer: on a much larger scale than may be at first supposed. Why should it not be applicable to a portion at least of land now set apart for the production of winter potatoes? We can see no reason why it should not. In the case of winter potatoes the land might be sown with rape instead of turnips. But what we now have to do with is the cultivation of early potatoes. Within the last three years the growth of early potatoes has been almost trebled.

But surely, it may be said, the land in this district must be most favourable for the produce of the potato—in other districts it would be impossible.

We do not say that every district could do the same, but we believe that *many* districts similarly situated, and possessing similar soil, might. "Oh," says A," you have sea-sand, and seaweed, and muscles, and that sort of thing—all of which are essentially requisite for early production; and as it would never pay to convey these commodities inland for the purpose of carrying out such a course, it would never pay."

A few years ago this objection might have had some force, but since the importation of guano, and the manufacture of many valuable artificial manures brought to light through chemical science, it is futile—for experience has proved that these artificial manures are equally beneficial with the muscles, &c., and indeed are now extensively employed.

There are, however, two advantages in favour of this locality which are not general—first, the low level above the sea, and, secondly, the sandy gravelly soil.

The great drawback to the cultivation of the early potato is the injury inflicted by the severity of spring frosts. But these are less severe by the sea-coast than inland. Even at a distance of four miles it has been observed that the frost has been very sharp, whilst by the sea-coast there has been little or none. Consequently, the plants have been much injured inland, whilst they have escaped with little or no injury along the sea-shore. So, again, there is the local advantage of a suitable soil; for here it may be remarked, that potatoes growing upon *hard* land, or a sandy loam, for instance, will escape the frost, whilst the next field, moss or clay, will be cut down.

It would then appear that there is great uncertainty with regard to the value of the produce; and so there is, but the uncertainty is whether you realise 50*l.* or 70*l.* per acre. Those potatoes are only planted which are known to recover quickly from the effects of the frost. Indeed, we can scarcely remember a year in which the potatoes have not been cut down once or twice when one or two inches out of the ground. After such a catastrophe there is a general lamentation, "Fair frozzen clean to t' ground; waint be worrth a farding." But the knowing ones take it very quietly, for they know that the frost will have been more severe inland, and that others must have suffered more, so that in the end they will be rather gainers than losers.

It is, however, strange how little known the kinds of potato are which are here so profitably cultivated. In other districts we have found the ash-leaved kidney in high favour. They have been tried here, and are found by no means equal to the "lemon kidney," which is equal in production to the ash-leaf, earlier in forwardness, and far superior in flavour and quality. There is always a great difficulty in obtaining good seed. Genuine seed commands a high price, and not without reason, for the growers take the greatest pains in cultivating the seed for their next year's crop; for example, they set not the small refuse which is generally done, but select equal well-shaped tubers as smooth as pebbles, and as soon as any one shows a *flower* it is immediately eradicated. A flower to an early potato is considered a sign of deterioration, the first symptom of growing out; it being

contended that all the strength of the plant should be thrown into perfecting the tuber, and not be spent in the opposite extreme. However this may be, it is certain that a plant when it has once shown a tendency to flower is not so early in perfecting its tubers, and that the seed set from such a plant will shortly produce tubers irregular in shape and deformed by little knobs and excrescences. The more forward, the earlier, the sooner it is ready to be taken up for use, the higher price it will command; and the more perfect and equal in shape, the more valuable, because there is less waste in preparing it for table. And here we must beg to correct a misstatement. It has been frequently remarked that potatoes are not good to eat until winter ones come in; and generally speaking there is a good deal of truth in the remark. In many counties we could name, what is there called a new potato is one of the worst and most unwholesome of vegetables. "How can you like new potatoes?" we have been asked, with a look of surprise expressive of commiseration; "they are such heavy, waxy, indigestible things;" and so *they* are.

It may seem a vain boast, and we may be laying ourselves open to the charge of prejudice, but this we can truly say, that we never ate a new potato equal to or to be compared in excellence to those cultivated in this district and its vicinity. There is almost as great a difference between other new potatoes and the Morecombe ones as between chalk and cheese. Light and digestible, they form a dish fit for an epicure; not heavy, *livery* balls, which you see continually sent up to table in the summer season, but light and flowery, the delicate skin cracked and bursting. Such has been the demand for this favourite esculent that the markets of Leeds, Bradford, and many other large towns in Yorkshire, have been supplied from this district. Before the opening of the North-Western Railway and its connexion with the Midland, new potatoes were sent to Covent Garden market from hence, where they met in competition produce sent from Cornwall. But latterly markets have been opened nearer home, and large quantities are daily forwarded during the season to Derby, Sheffield, Birmingham, Leicester, and Cheltenham. Hundreds of tons are thus weekly despatched, and the demand continues to increase.

The rent of land is, as may be supposed, proportionably high. Some is let at the rate of 16*l*. per statute acre. We have in our mind's eye a field, broken up last winter, now let at 3*s*. 5*d*. per rod of 49 yards.

A good crop will yield 10 score lbs. per rod, which, at 1*s*. 6*d*. per score, would amount to 15*s*. per rod, or about 70*l*. per acre in round numbers.

The difference of expense in cultivating early potatoes and late or winter ones is not great. Some adopt the plough, and plough the sets in every other furrow, whilst others employ spade husbandry. It is astonishing how quickly a labourer, attended by a boy to put in the sets, will complete an acre with the spade. Of course the land is previously prepared.

Earlier in the season—in the middle of June—prices are considerably higher than that above mentioned. From 2*s.* 6*d.* to 3*s.* per score the price will extend; but then the produce is less in quantity, though we have known instances of six and seven score obtained per rod at those prices.

After the lemon kidney, which will supply the consumer from June to August, comes an excellent *second early*, the red eye, which continues good from August to the following May. Last year a crop of these potatoes was lifted before the end of August, kept perfectly sound and free from disease, and the last of them was eaten in the middle of May.

The mode of obtaining potatoes matured for lifting so early as August is very simple. You merely have to set them well sprouted. There is no occasion to put them in early—the last week in April or first week in May will do, and they will be ready by the end of August, when the land may either be sown with rape or with grass seeds for meadow or pasture. If sown with the former, it may be eaten off by sheep and ploughed again for potatoes the following spring, and so on.

There appears to be, in this neighbourhood at least, a stage at which the potato is more liable to take the disease than at other periods of its growth. The month of August is the critical time for the winter potato. But by sprouting the tuber before setting you obtain nearly a month's advantage, so that when the disease does come the plant is in a stronger state than it would otherwise be, and is thereby enabled to repel the attack.

This we know for a fact, that the same variety of seed, set at the same time in the same field and not taken up till October, were much diseased; whilst those taken up in August kept perfectly sound.

The third variety of potato which has proved most free from unsoundness is the *Fluke.* This is a late winter potato, and the least liable to disease of any of the winter varieties with which we are acquainted. The fluke is very productive, and grows to a large size. In many soils they retain a sweet, yam-like flavour until Easter, when it will disappear, and become a first-rate vegetable until new ones come in.

But in order to give our readers more accurate information it will be necessary to enter further into detail, and describe the mode of cultivation here practised, from the preparation of the

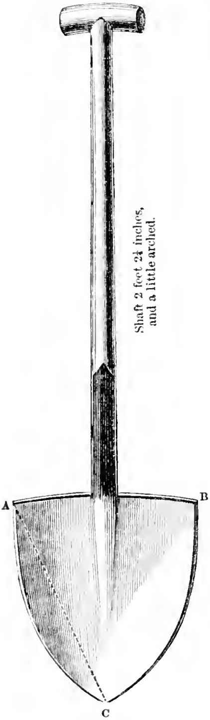
land for the seed to storing; including the method of sprouting, upon which the profit of the lemon kidney in a great measure depends; and we think would also prove advantageous if applied to the growth of *late* potatoes.

And first, we shall commence with the preparation of the ground, keeping in mind the nature of the soils before mentioned. Let us then take a small field—an acre or two of arable land—for we would by no means recommend a beginner to commence with a larger plot. For be it remembered that the cultivation of the *early* potato, though similar in many ways to that of the late, yet differs in many respects. A farmer who has been accustomed to cultivate his thirty or forty acres of potatoes may ridicule the idea of making so much of so small a matter, and remind us of a "certain mouse and a certain mountain," which have *not* escaped our recollection. He may treat it as a joke: but we should be acting unkindly, at least, if we did not, in recommending the adoption of our system to more general practice, add a word of caution to the recommendation. We should be sorry to be the means of involving any novice in what might prove to him an unprofitable investment. What, then, we have said, we must beg to repeat. Make only a small beginning, and increase year by year as you find you are enabled to work to profit. You must remember that the period of cultivating the *early* potato is very limited, and is by no means as extensive as that of the *late* varieties. Indeed, from *eight* to *ten* weeks is the usual time from the period of setting to lifting.

But to return to the preparation of the soil. Select a dry sandy loam, and, supposing it to be a corn-stubble, you should cart your manure on to the land in February. If the field be pasture or meadow-land, it would be better to take a crop of oats from it the first year; or the field must be trenched and the sod turned down on its face to the bottom of the trench.

Short, well-decomposed horse and cow manure should be spread on the land to the amount of 30 tons per acre; *long* manure will not answer, for it does not work as soon, and moreover drags and impedes both plough and spade. The manure, when spread, must be ploughed down when the land is *dry*. If the land is not dry, you must wait till it is; in this case, let the manure remain in the heaps in which it has been set out from the cart until the land is in a proper state. It is the general practice to spread the manure just *before* the plough, and a very good practice it is, to prevent waste and loss of ammonia, &c. You had better do nothing than attempt to prepare the land in a wet state, you would only be defeating your own object. It is a matter of greater importance than is generally considered not to meddle with it until it is dry.

If you first plough the land in a wet state, it will take much longer time to dry and to get it into proper condition than if it had been left alone. The state of perfection which you should endeavour to attain is to make the land as dry and as *free* as oatmeal. After the manure is ploughed down, say in February, the land remains in that state till the end of March or the beginning of April, the second week in April being considered the best period; for if you set sooner your crop is liable to suffer from the early spring frosts, and if you set later your crop will come in too late for the early markets.



A to B 12½ inches.
A to C 13¼ „
Shape concave.

You recommence operations, then, by harrowing the land that was left in furrows, then plough it again—always selecting a dry time—and harrow; and should it not then be reduced to a fine state of tilth, you must plough it again, but do not harrow the last time previous to setting, as it is requisite the land should be left in as light condition as possible.

Supposing, then, it is your intention to adopt spade husbandry (which we believe to be preferable), when the land is thus prepared the labourer must be provided with a suitable implement in the way of a spade—we do not mean a common square garden-spade, but one, to save further description, of this shape and size. A narrower implement would not answer the purpose, for the object is to stir the whole of the ground. And if two or more labourers are employed, care must be taken that all be provided with spades of *equal* width; for should one spade be wider than another, it will follow that there will be a greater width between some rows than others—a consequence which, at the time of moulding up, would be attended with inconvenience.

And now we come to the setting. The potatoes are carefully taken up from their sprouting-places, and placed in small baskets with a bow handle. Those which have more than one good strong sprout are generally cut *length*-ways, never *cross*-ways.

Some never cut them at all, but rub off the second sprout, which is, we are inclined to think, the best plan. The baskets are then carried to the field; these baskets contain about 20 lbs., and therefore can be moved about with ease, and are committed to the care of the setter, generally a boy of about fourteen years of age.

The labourer with the spade—or "*shooler*," as he is called—commences his work by throwing out a furrow about 2 inches deep. It is not necessary for him to use his foot,—the mere action of the arm, with a peculiar shove, is quite sufficient to enable him to extract the soil; the width of the furrow is, of course, the same as that of the spade. Then the setter follows the shooler, and places the sets, *i. e.* sprouted tubers, about 12 inches apart on the bottom of the furrow. As soon as the setter has got 5 or 6 yards down the furrow, No. 2 shooler commences with his spade to cover the sets which the boy has planted, and, by so doing, he prepares a bed or furrow for the next setter. One active boy will keep at work two shoolers, but it is as well to provide a boy for each man; for if he has—as he ought to have—time to spare, he may be employed in forking the head-lands, or in fetching more potatoes. And in case the land should not have been previously manured, then the setter has to put in the guano and other artificial manure, as well as to set. Care, however, must be taken that the seed be not placed in the guano, but above it.

The distance between the rows will be about 14 inches. The labourers in this neighbourhood are so accustomed to this kind of work that they can, without looking behind them, go as straight as a line: indeed they never use a line. They take great pains in forming the first furrow, and, by keeping their eye upon the edge of the furrow nearest to them, which forms of itself a natural line, they draw the next parallel.

A man will "shool" about one-eighth of an acre per diem; we have known men accomplish a quarter of an acre, but this is excessive, and we are inclined to think that the quantity first mentioned is nearest the average quantity of work.

About a fortnight after the land is set, a small light harrow is drawn over the ground, when the land is dry, to kill or check the springing weed. We do not ourselves approve of this plan, for, though it no doubt checks the young weed, we are of opinion that the teeth of the harrow break off many young sprouts. This implement is called a potato harrow, and is made for the express purpose. The teeth are of iron, set in wood, and about 3 inches in length; it is very light and drawn by a man, as a horse or pony would break the sprouts.

After this operation the land is let alone until the plants may

be distinguished in the row, then *flat*-hoeing commences; in fine dry weather once will suffice; but should the weather be showery or rain fall immediately, twice or thrice will be necessary.

When the land is clean "moulding" may be commenced. It was the custom to do this with the hoe, hence the terms of *flat*-hoeing and "hoeing-*up*;" but of late a small iron plough, with moulding-boards, has been introduced by a resident gentleman, and this has now become generally adopted. The plough is drawn by a man and boy, another man holding the stilts. The quantity of ground they will go over in a day far exceeds what they could accomplish with the hoe.

And here may be seen the necessity of having the rows at equal distance; for though the mould-board might certainly be adjusted to an inch or two wider or narrower, yet this would involve an unavoidable delay at the end of each row. And we all know that when three men stop it requires some little time to set them a-going again; there is some remark to be made which, somehow, cannot be made on the move; some sentiment to be expressed which would probably lose its point "*en passant*;" at any rate, there is a difficulty in effecting a fresh start, and much time is lost. Now the best time for performing this operation is either early in the morning or late in the evening, say before 8 A.M. or after 6 P.M., for then the plants have drawn up their leaves and they escape injury: whereas, if they were moulded-up during the heat of the day, the rootlets would be scorched, and the plant droop.

Four weeks or so after the moulding, the crop (we are now speaking of "lemon kidneys") will be ready for lifting; and though they would doubtless increase rapidly in weight if permitted to remain a fortnight longer, yet, if the prices be high, say about 2*s.* 6*d.* per score, they will never pay better. The first symptom of the crop being ready is the curling of the lower leaves; after these turn *yellow* the tuber will not increase much in weight. In lifting, or "getting up," as it is here called, the fork with three prongs is used. One man with a fork is attended by three boys: the first to shake the mould and potatoes off, the second to pick up the large ones, and the third the small ones. The latter are sold at half-price, the former packed up in hampers and barrels and forwarded to different markets.

As soon as the land is cleared, it is ploughed and prepared for sowing turnips, or transplanting swedes and mangold-wurtzel. A second manuring is the exception, and not the rule.

We now come to another important point. We have spoken of the preparation of the land, we have now to speak of the preparation of the seed. In order to ensure success and command

high prices, the seed must be *sprouted*, *i. e.* it must have made an advancement in growth of at least an inch. This sprout should be strong and well developed, its thickness about that of the stem of a common tobacco-pipe, and its top crowned with green buds just bursting into leaf; at the bottom of the sprout are emitted, or in the course of emission, small threadlike roots, which, as soon as planted, take possession of the soil. Here is the grand secret of obtaining *early* potatoes.

To acquire this stage of advancement many expedients are resorted to. It is the natural habit of the lemon kidney to sprout early; indeed oftentimes there is a difficulty in retarding this movement, for, if the sprout be too long, it runs great risk of being knocked off in course of setting. The mode here adopted by the cottagers is no less original than ludicrous. After Christmas the seed is taken out of store, whether from "pits," or "graves," or elsewhere. The potatoes are then brought into their houses and placed under their beds. When these recesses are filled, they fill small baskets, of same kind and dimensions as those from which the seed is planted, and hang them up on hooks to the ceiling of their apartment down stairs, to obtain the advantage of the warmth of the fire, and thus proceed to fill every possible place where they may be kept from the frosts. If a man possesses a cowhouse or stable, the rafters are forthwith adorned with hooks, and the little baskets suspended. The breath of cows is very beneficial. Care, however, must be taken that the sprouts do not become blanched and weak: they must have plenty of light.

One of the largest cultivators in this district has improved upon the cottagers' plan, and has converted the hay-lofts over his horses and cows into "sprouting-rooms." Above these lofts he has laid a second floor, so that he is enabled to sprout double the quantity. The warmth arising from the cattle has been proved to be quite sufficient to keep out the frost.

The tubers should not be placed thicker than 2 inches deep, or the roots would become one mass of sod.

Unless, then, some other mode be devised, or sprouting-houses be purposely erected, there will remain the difficulty—the impossibility, we had almost said—of any one grower setting as large a quantity of early as of late potatoes.

And again, as we before observed, the period of cultivation is so short, and the work to be done in that time so pressing, that it would require an incredible number of hands, and of hands probably totally unaccustomed to this kind of work. At the time of setting you would require a man and a boy per acre; then there would be a cessation from labour for about a fortnight or so, until the time for moulding-up, and when this was finished

there would be another interregnum until they were ready for getting up. Three shoolers will keep a pair of horses preparing the land for them.

In "dropping" weather the hoe must be kept constantly at work. The ground that has been gone over one day must be gone over again the next. You must keep ahead of the weeds, and pace with the growing crop.

"But why not cultivate them," some one may say, "in the same way as the late varieties?" We cannot afford to do so; the land is too valuable. Were the "winter" plan adopted, we should only be able to obtain one-third of the number of rows per acre, and consequently would lose one-third of the value.

We before mentioned that, in the cultivation of the seed for the following year, all plants showing flower, as well as all others which manifest a diversity of leaf, are carefully eradicated. From the field the seed is taken to the barn, spread on the floor about 1 foot thick, and kept in the dark. Here they are suffered to remain for a month, when, if no disease appears, they are removed, and may be considered safe. At least this is the plan we would recommend, and which has been proved to be most successful; for we have known potatoes, when brought from the field, to have been just tilted up on the barn-floor, and have observed that in these large heaps symptoms of disease have appeared, whilst none have been detected amongst those which have been spread. We presume it was owing to the sweat not being permitted to escape and dry as readily as when laid in smaller heaps.

After Christmas is turned the potatoes are brought out of the "hogs," or "graves," or "pits"—all of which are provincial terms for the same mode of covering them with straw and earth—and are laid for "sprouting." We cannot refrain here from expressing an opinion that it would be desirable to extend this sprouting to all the late varieties. Amongst lemon-kidneys we never hear of disease, at least amongst those which are got up for the markets in July. Some slight traces may be found in August, whilst those lifted in September and October have been much affected; and the same observation may be made with respect to red eyes, —the crop taken up in August has been found and kept sound, whilst in those taken up later there has been considerable loss. We are, therefore, induced to think that, if the winter varieties were set well sprouted, they would run much less risk and a great saving of food be effected. We have no business to take up lemon-kidneys in September and October, but the cottagers will risk it, and they set for seed after they have got up and sold their first crops. They calculate that they shall lose one half by disease, and, if they only preserve the remaining half, they obtain

a more valuable crop than by sowing or transplanting any other vegetable. The great objection to sprouting is the expense and want of convenience; the former is very trifling, and the latter is generally at hand. Any cattle-shed would answer the purpose; a few rough slabs to form a floor above the cattle, whereon to spread the potatoes, would be quite sufficient. So long as you can keep up the temperature above freezing-point they will not suffer, and this the breath of the cattle would effect.

With regard to protecting the young plants from frost little here is at present done. A few borders in sheltered places are covered with straw screens; posts are driven into the ground, on which are nailed strips of wood to support the screen. Some few use calico instead of straw; they are much lighter and handier to lift off and on, but they are difficult to manage in a high wind. We have seen a much better plan. A friend of ours has contrived a kind of sheet or sail, made of calico, which will furl and unfurl *ad libitum*. It is attached by rings to wires fastened to poles driven into the ground, and upon these wires it is made to run up and down by means of a cord and pulley. This plan has been proved to be efficient to repel this spring's frosts, which have been unusually severe, and therefore there is little doubt but that the experiment will be enlarged upon.

In conclusion, we must caution our readers against the purchase of seed. We had almost said a potato is frequently not a potato, but we may safely say a kidney is not necessarily a *lemon* kidney. Of kidney potatoes there is an endless variety: there are the "short-top," the "rough-top," the "Yorkshire" or "winter-kidney," the "walnut-leaf," and the "ash-leaf," &c. And the worst of the matter is, that if you order a load of early kidney potatoes you will, in all probability, get *all* the varieties. Of course, there are exceptions to this rule, but we speak generally, and, what is more, we speak from experience. Even here, where the best and earliest varieties are grown, it is very difficult to obtain good and unmixed seed. In fact, you must see them growing; and, when you see them growing, you must have the eye to discover whether they all have the same kind of leaf and habit of growth, and equal absence of flower.

Here all early potatoes are included under the general term "lemon kidneys," as in other places they are denominated "ash-leaves." But amongst these "forrart uns," as they call them, there are many varieties. Some have a broad, round, shiny leaf; this is the true lemon kidney: some have narrow pointed leaves; others small curly leaves; whilst a fourth exhibits a small rough round leaf. We should, therefore, recommend such as are anxious to cultivate the true lemon to obtain

a small quantity of the genuine kind and rear their own seed, if they would avoid the disappointment of a mixture.

It is only reasonable to conclude that if you have a mixed lot some will be ready to be lifted whilst others are only just forming their tubers, so that you must either let them stand till the latter are ready, by which means you lose the advantage of an early market, or you must get them up as they are and sacrifice the late ones; either way involves a loss.

The growers who possess genuine seed are loth to part with it; to obtain a few stones weight at a high price is considered a favour. If you can obtain some at 1*s*. 6*d*. per stone you may consider yourself very fortunate; we have known as much as 2*s*. 6*d*. asked and given.

In cultivating the *late* varieties we would strongly recommend the adoption of sprouting, which we believe to be, if not a panacea, yet one of the best of the few remedies hitherto prescribed. Set the red eye and fluke when the land is in *fine* order, wait if necessary until as late even as the end of April or beginning of May. Set them well sprouted, and you will be astonished at the rapidity and luxuriance of their growth. In the first place you insure a plant, you have no misses, no blind eyes, but up they come regular and equal, like a well-disciplined regiment of soldiers, every one in its place. They will be ready for "getting up" full a month before others set in the ordinary way; and when the annual complaint arises that the disease has again appeared, you will have taken up your crop in a good state of preservation.

We prefer getting them before they have attained a state of maturity, rather than run the risk of obtaining greater weight by allowing them to remain longer in the ground to ripen. The tubers will not be quite so large, but they will be sound; and if the cultivator were to calculate the almost endless expense of turning over his store and picking out the diseased ones, he would find himself a considerable gainer in securing a crop of sound middle-sized potatoes.

Last year both red-eyes and flukes were taken up before they were ripe: the skins were abrazed, and when brought home from the field they presented a ragged and bruised appearance, anything but sightly; but in the course of a month or so this unsightliness disappeared, the tubers recovered, and became quite mature; when eaten they proved excellent. Many who saw them at first exclaimed that they were spoilt, "what a pity it was, &c.; they would be good neither for eating nor for seed." But these very potatoes kept sound and good, not one went bad, and the last were eaten after Easter.

Doubtless there exists a great obstacle to the large cultivator

in the way of "sprouting." How can he sprout seed for thirty or forty acres? We must confess that there is a difficulty, yet with a little contrivance, by making use of the cattle-sheds and outbuildings which we may suppose such an occupier to possess, he might sprout sufficient for several acres, and when he found the advantage of so doing he might add to his contrivances.

But there are hundreds of small cultivators who would have no difficulty at all in the matter. Let the man who now grows his half-acre for his own family consumption—and how many such there are!—try the sprouting system, and we are persuaded that the saving of food would be something enormous. It may be considered audacious to say so, but we cannot but look upon the potato disease as one of the strongest incentives to greater industry and energy on the part of the cultivator; and should the end of the affliction amount to almost a compulsion to obtain two crops a-year instead of one, we shall have no cause of complaint, but feel thankful to Him who can mercifully bring good out of evil.

Morecombe, 1857.

VII.—*On Farmyard Manure, the Drainings of Dung-heaps, and the Absorbing Properties of Soils.* By Dr. Augustus Voelcker.

It is a prevailing opinion amongst farmers that the peculiar smell which emanates from dung-heaps is caused by the escape of ammonia, and that the deterioration of farmyard manure is due, in a great measure, to the loss of this most fertilizing substance, which is incurred by careless management of dung-heaps. In a paper published in the volume for 1856 of this Journal, however, I showed that the proportion of free ammonia, or rather volatile carbonate of ammonia—for it is in this form that ammonia makes its appearance in putrefying organic matters—is so inconsiderable in fresh as well as in fermented dung in all stages of decomposition, that it is not worthy to be noticed in a practical point of view. This being the case, it is evident that the escape of ammonia cannot be the cause of manure-heaps losing much in fertilising property even when freely exposed to the atmosphere for a considerable length of time. Consequently the chemical means which have been suggested from time to time for preventing the loss of ammonia in dung-heaps may be altogether dispensed with. As there is, practically speaking, no free ammonia in either fresh or

rotten dung to be fixed, the addition of dilute sulphuric acid, a solution of green vitriol, and other chemical agents which change volatile compounds of ammonia into non-volatile combinations, is unnecessary and useless. At any rate, these and other fixers of ammonia are useful additions to dung-heaps only in so far as they themselves possess fertilising properties. In the paper to which reference has been made, I furnished experimentally the proof that, simultaneously with the formation of ammonia—which always proceeds when organic substances containing nitrogen enter into putrefaction—under ordinary circumstances, ulmic, humic, and similar organic acids are produced, which, on account of their great affinity for ammonia, lay hold of any free ammonia generated from excrementitious matters and effectually fix it, provided the temperature of the heap is kept down sufficiently low. In the interior of a dung-heap, where the heat rises often to a temperature of from 120° to 150° F., ammonia, indeed, is given off so abundantly that its presence here becomes patent by its characteristic pungent smell. Such a smell is always observed on turning a manure-heap in an active state of fermentation. Fortunately, the external cold layers of dung-heaps act as a chemical filter, and retain the ammonia proceeding from the heated interior portions of the heap so effectually that even a delicate red litmus paper is not altered in the least. As the faintest traces of ammonia turn reddened litmus paper distinctly blue, it is plain that, however strong the smell of a dung-heap may be, it cannot be due to the escape of ammonia if the red colour of the paper is not turned blue by holding it, previously moistened with water, close to a dung-heap. Some doubts having been expressed of the accuracy of this observation, I have repeatedly examined manure-heaps for free ammonia. Numerous experiments, which need not be described in detail, have fully confirmed my former observations. It is true a manure-heap which has just been turned, or which is examined the day after, gives off a small quantity of ammonia. Although this amounts to a mere trace, yet it distinctly affects red litmus paper; but when a dung-heap is allowed to consolidate for a week or so, and is then examined with litmus paper, not a trace of free ammonia can be detected in the air close to the dung-heap, whilst no difficulty is experienced in detecting free ammonia in the interior heated portions of the same heap. I have since found that farmyard manure, perfectly free from volatile carbonate or uncombined ammonia, when macerated in boiling water, gives off a slightly pungent smell, which, as far as its pungency is concerned, is caused by the escape of ammonia.

It appeared to me a matter of some interest to investigate the

circumstance that ammonia is given off only in the interior of the heap and not from its surface, and also how it is that manure which does not contain a trace of free ammonia at the heat of boiling water gives off this gas in appreciable quantity. In the course of this investigation, I was led to the chemical examination of the drainings of dung-heaps, and obtained results which, I believe, are of sufficient interest to be recorded in a Journal devoted to the promotion of good agricultural practice and sound scientific principles.

Before describing the nature of my experiments with drainings of dung-heaps, and stating the analytical results obtained in the analyses of this liquid, I may be allowed to offer a few additional experimental proofs in support of some of the opinions advanced in my paper on the changes which farmyard manure undergoes on keeping. In order to obviate frequent reference to this paper, I would observe that, amongst other particulars, I showed that perfectly fresh as well as rotten dung contained but a very trifling amount of free ammonia; that short dung, when properly fermented, contains more nitrogen than long dung; for which reason, weight for weight, rotten dung is more valuable than fresh. Respecting the loss which farmyard manure sustains under various circumstances, I furnished numerous experiments, which prove that farmyard manure is deteriorated in value when kept in heaps exposed to the weather—the more the longer it is kept; and that the loss in manuring matters which is incurred in this way is not so much due to the volatilization of ammonia as to the removal of ammoniacal salts, soluble nitrogenized organic matters, and soluble mineral matters, by the rain which falls in the period during which the manure is kept. I further showed that well-rotten dung is more readily affected by the deteriorating influence of rain than fresh, and that no advantage appears to result from carrying on the fermentation of dung too far. Finally, I described several experiments, which led me to the conclusion that the worst method of making manure is to produce it by animals kept in open yards, inasmuch as a large proportion of valuable fertilizing matters is thereby wasted in a short time, and suggested, as the most effectual means of preventing loss in fertilizing matters, to cart the manure directly on the field, and to spread it at once, whenever circumstances allow this to be done.

Since the publication of my former experiments on farmyard manure, I have had an opportunity of examining some sheep-dung in a highly advanced state of decomposition. This examination has brought out strikingly that the richest excrementitious matters are greatly deteriorated in value by keeping for an

immoderate lengthy period, and I may therefore be permitted to state here the results in full.

The sheep-dung operated upon was furnished to me by a farmer residing in the neighbourhood of Cirencester, who kept this dung for three years in a heap, probably with a view of manufacturing it into a first-rate turnip manure. It was completely decomposed, appeared as a black greasy mass, and possessed more of an earthy than an animal smell.

A well-mixed sample, on analysis, yielded the following general results:—

General Composition of Decomposed Sheep Dung (3 *years old*).

	In Natural State.	Calculated Dry.
Water	73·66	..
*Soluble organic matter	2·70	10·25
Soluble inorganic matter	2·66	10·09
†Insoluble organic matter	9·95	37·78
Insoluble mineral matter	11·03	41·88
	100·00	100·00
* Containing nitrogen	·157	·590
Equal to ammonia	·190	·716
† Containing nitrogen	·470	1·790
Equal to ammonia	·580	2·170
Total amount of nitrogen	·627	2·380
Equal to ammonia	·770	2·886

A delicate reddened litmus paper inserted into the neck of a wide-mouthed bottle, into which some of this sheep-dung was placed, was not altered in the slightest degree; there was thus not a trace of free ammonia present in the dung.

When boiled with water, a small portion of ammonia was given off, but that quantity was so insignificant that I determined at once the total amount of ammonia which existed in the dung in the form of ammoniacal salts. This was done by distillation with quick lime and collecting the liberated ammonia in hydrochloric acid, evaporation to dryness in a water-bath, and weighing the residue consisting of sal ammoniac.

Proceeding in this way, I obtained from 100 parts of completely decomposed sheep-dung—

	In Natural State.	Calculated Dry.
Ammonia	·034	·129
(In the state of ammoniacal salts.)		

It appears, therefore, that the amount of ammonia present in the form of ammoniacal salts is exceedingly small.

In separating the soluble from the insoluble portion some very finely divided silica passed through the filter, and was obtained in the soluble portion of the ash.

This portion of the ash contained in 100 parts :—

Completely Rotten Sheep-Manure.

Composition of Ash of portion Soluble in Water.

Soluble silica	30·70
Insoluble silica	15·90
Phosphate of lime	21·70
Lime	3·93
Magnesia	6·37
Potash	14·14
Soda	3·15
Chloride of sodium	·85
Sulphuric acid	2·86
Carbonic acid and loss	·40
	100·00

The composition of the insoluble portion of the ash is stated in the next diagram :—

Completely Rotten Sheep-Manure.

Composition of Ash of portion Insoluble in Water.

Soluble silica	11·25
Insoluble silica	62·81
Oxides of iron and alumina, with phosphates	9·12
containing phosphoric acid	(4·93)
equal to bone earth	(10·68)
Lime	7·95
Magnesia	2·88
Potash	·59
Soda	·50
Sulphuric acid	1·18
Carbonic acid and loss	3·72
	100·00

From these results the composition of the whole ash of sheep's dung, kept for three years, has been calculated and embodied in the subjoined table.

Completely Rotten Sheep-Manure.

Composition of whole Ash.

Soluble in Water, 19·41 per cent.	Soluble silica	5·95
	Insoluble silica	3·08
	Phosphate of lime	4·21
	Lime	·76
	Magnesia	1·28
	Potash	2·74
	Soda	·61
	Chloride of sodium	·16
	Sulphuric acid	·55
	Carbonic acid and loss	·07
		(19·41)

			Arranged together.
Insoluble in Water, 80·59 per cent.	Soluble silica	9·06	15·01
	Insoluble silica	50·61	53·69
	Oxides of iron and alumina with phosphates	7·34	7·34
	containing phosphoric acid	(4·07)	(4·07)
	equal to bone earth	(8·52)	(8·52)
	Phosphate of lime	..	4·21
	Lime	6·40	7·16
	Magnesia	2·32	3·60
	Potash	·47	3·21
	Soda	·40	1·01
	Chloride of sodium	..	·16
	Sulphuric acid	·95	1·50
	Carbonic acid and loss	3·04	3·11
		(80·59)	100·00
		100·00	

A comparison of the ash of sheep's dung, kept for three years, with the ash of well-rotten good common farmyard manure, will show that in the latter the proportion of phosphate of lime is somewhat larger, and that it is especially much richer in potash than this sheep's dung. On the other hand, this sample of sheep's dung contains a great deal more of silica and earthy matters insoluble in water.

It is thus evident that by long keeping the most valuable inorganic constituents of sheep's dung are washed out gradually, and by their loss the dung becomes greatly deteriorated in fertilising properties.

The next Table exhibits the detailed composition of this completely rotten sheep's dung.

Completely Rotten Sheep-Manure.

Detailed Composition of Manure in Natural State.

Water		73·66
* Soluble organic matter		2·70
Soluble inorganic matter (ash):—		
Soluble silica	·801	
Insoluble silica	·422	
Phosphate of lime	·577	
Lime	·104	
Magnesia	·169	
Potash	·376	
Soda	·083	
Chloride of sodium	·022	
Sulphuric acid	·076	
Carbonic acid and loss	·030	
		2·66
Carry forward		79·02

Brought forward		79·02
† Insoluble organic matter		9·95
Insoluble inorganic matter (ash):—		
Soluble silica	1·240	
Insoluble silica	6·927	
Oxides of iron and alumina, with phosphates ..	1·005	
containing phosphoric acid	(·543)	
equal to bone earth	(1·176)	
Lime	·876	
Magnesia	·317	
Potash	·065	
Soda	·055	
Sulphuric acid	·130	
Carbonic acid and loss	·415	
		11·03
		100·00

* Containing nitrogen	·157
Equal to ammonia	·190
† Containing nitrogen	·47
Equal to ammonia	·58
Whole manure contains ammonia in free state, and in form of salts	·034

According to these results, the same dung in a perfectly dry condition has the following composition:—

Completely Rotten Sheep's Dung.

Detailed Composition of Manure in Dry State.

*Soluble organic matter		10·25
Soluble inorganic matter (ash):—		
Soluble silica	3·097	
Insoluble silica	1·604	
Phosphate of lime	2·189	
Lime	·405	
Magnesia	·642	
Potash	1·426	
Soda	·317	
Chloride of sodium	·085	
Sulphuric acid	·288	
Carbonic acid and loss	·040	
		10·09
†Insoluble organic matter		37·78
Insoluble inorganic matter (ash):—		
Soluble silica	4·711	
Insoluble silica	26·304	
Oxide of iron and alumina, with phosphates	3·819	
containing phosphoric acid	(2·06)	
equal to bone earth	(4·46)	
Lime	3·329	
Magnesia	1·196	
Carry forward		58·12

Brought forward		58·12
Potash	·247	
Soda	·209	
Sulphuric acid	·494	
Carbonic acid and loss	1·557	
		41·88
		100·00

* Containing nitrogen	·59
Equal to ammonia	·716
† Containing nitrogen	1·79
Equal to ammonia	2·17
Whole manure contains ammonia in free state, and in form of salts	·129

From these analytical results it appears—

1. That completely rotten dung contains less soluble organic matters than well rotten common farmyard manure.

2. That the proportion of insoluble organic matters in such sheep's dung is also much smaller than in rotten yard manure.

3. That the amount of nitrogen in rotten farmyard manure is greater than in this sheep's dung.

4. That, weight for weight, ordinary well rotten dung is more valuable than such completely decomposed sheep's dung.

When it is considered that the diminution of manure in weight by long keeping is very considerable, and that the remaining manure, reduced it may be to one-third its original weight, is less valuable than even common farmyard manure, the folly of keeping sheep's dung in a heap for a number of years will become apparent.

As it may not be uninteresting to compare this manure with fresh sheep's dung, I will insert here a Table representing the general composition of fresh sheep's dung, as recently determined by me:—

General Composition of Fresh Sheep's Dung (Sheep fed upon Roots on old Pasture.)

	In Natural State.	Calculated Dry.
Moisture	73·13	..
* Organic matters	20·28	75·47
Inorganic matters (ash)	6·59	24·53
	100·00	100·00
* Containing nitrogen	·95	3·53
Equal to ammonia	1·15	4·29

Fresh sheep's dung thus contains considerably more nitrogen than the sample of completely rotten dung which was analysed by me.

During the first stages of the fermentation of dung the proportion of nitrogen in manure increases, but when well-fermented

dung is then exposed to the weather, the nitrogenized constituents which have been rendered soluble during the process of fermentation are liable to be washed out by rain. The analyses of fresh and completely rotten sheep's dung confirm my former observations—that in this way a great loss is incurred in valuable fertilising matters.

As a further proof of the fact that both fresh and rotten farmyard manure contains but a trifling amount of free ammonia, I have to mention two experiments.

The first was made with fresh horse-dung, or, more properly speaking, with the recent droppings of horses mixed with straw; that is, horse-dung as found in stables before its removal to the dung-pit.

This manure contained in 100 parts:

Water	76·60
Solid matter	23·40
	100·00

The percentage of ammonia, which was driven out by long-continued boiling, amounted to ..	0·0033	
Quicklime added to remainder expelled in addition to this quantity	0·062	p. ct. of am.
The total amount of nitrogen in this manure amounted to	0·387	p. ct.
Which is equal to	0·469	p. ct. of am.

Or dried at 212° F. the manure contained—

Nitrogen	1·655	p. ct.
Equal to ammonia	2·019	p. ct.

The second experiment was made with hot fermenting horse-dung, taken from the middle of a heap of good farmyard-manure, consisting chiefly of horse-dung. It emitted a strong and somewhat pungent smell, for reddened litmus paper inserted into the neck of a bottle into which some of this manure was placed turned blue after some time, showing that it contained some free ammonia. The quantity of the latter, however, was very inconsiderable, as will be seen by the following numbers, obtained like those in the experiment with fresh horse-dung:—

Percentage of free ammonia in fermenting horse-dung	0·049
Distilled with quicklime, it furnished additional ..	0·1103 p. ct. of am.

This manure calculated in 100 parts:

		Calculated Dry.
Moisture	68·74	..
* Solid matters	31·26	100
	100·00	
* Containing nitrogen	0·659	2·109
Equal to ammonia	·800	2·561

In fermenting horse-dung, the proportion of nitrogen is thus larger than in fresh, which agrees well with previous analyses of fresh or rotten common yard-manure; whilst in perfectly fresh horse-dung the amount of free ammonia is scarcely weighable, it being only about 3 parts in every 100,000 parts of dung, or 3 lbs. for every 40 tons; the same description of manure in an active state of fermentation yields somewhat more, but still a very inconsiderable quantity of free ammonia. Thus under the most favourable circumstances 100,000 parts of horse-dung yield only 49 parts of free ammonia; or in other words 40 tons in round numbers yield on long-continued boiling only 49 lbs. of ammonia. It must not be supposed, however, that this quantity of ammonia is dissipated into the air during the fermentation of the dung, for it is only in the interior of the dung-heap that ammonia is liberated. It is, indeed, only on turning a heap that ammonia escapes at all in any perceptible degree; but as soon as the external layers have become cooled down to the ordinary temperature of the air its escape is arrested. There can, therefore, be not the slightest doubt that a very minute quantity of ammonia passes into the air and the remainder is fixed in the heap, provided the heap is kept in such a manner that rain cannot remove from it much of the soluble matters, and with them ammoniacal salts.

The strong smell which is observed on turning a dung-heap no doubt has led many greatly to over-estimate the amount of ammonia which escapes from farmyard manure in an active state of fermentation. But I would observe that nothing is more fallacious than the estimation of the amount of ammonia by the pungency of the smell which is given off from fermenting animal matters. Such matters often give off a very powerful smell, which is due to peculiar volatile organic combinations—to some sulphuretted and phosphoretted hydrogen and a great variety of gaseous matters, amongst which there is ammonia gas in very minute quantities. The smell of this highly complicated and but scantily examined mixture of gaseous matters as a whole is ascribed by the popular mind to ammonia. From these products of putrefaction, however, ammonia can be completely separated, without in the least destroying the peculiar offensive smell which emanates from organic matters in a state of decomposition. If, for instance, dilute sulphuric acid is added to farmyard manure or liquid manure, the smell of these substances, instead of becoming neutralised by the acid, in reality becomes more offensive. This arises in a great measure from the liberation of sulphuretted hydrogen. Hence acids are not well adapted for disinfecting cesspools or nightsoil. As dilute sulphuric acid neutralises instantly free ammonia, forming with it an inodorous

salt, which is not volatile at the ordinary temperature, it is evident that the fœtid smell of putrefying matters has much less to do with ammonia than is generally believed.

The following experiment is decisive in this respect. A couple of ounces of genuine Peruvian guano were completely drenched with dilute sulphuric acid. Any free ammonia in the guano by the addition of acid must therefore have been instantly converted into sulphate of ammonia. The characteristic smell of the guano, however, was not removed nor even weakened by the acid. The guano moistened with acid was next dried in a water-bath for five or six hours, and during all that time gave off the strong peculiar smell which characterises genuine Peruvian guano. When dry it still smelt strongly, though weaker than when wet; but moistened again with a little water the smell again became as strong as before. In order to make quite certain that no ammonia would remain in a free state, I employed a great excess of acid, in consequence of which the guano, after drying up with acid, tasted as acid as any of the most concentrated samples of superphosphate.

I may further mention that I dried guano for days at a temperature of boiling water without being able to remove its peculiar smell.

Whilst speaking of guano it may interest some of my readers to learn that genuine Peruvian guano contains a very small quantity of volatile carbonate of ammonia.

There are many people who run wild with the idea that everything that smells strongly must contain free ammonia. Hence it is not surprising that salt, gypsum, acids, and various other substances should have been suggested to be mixed with guano for the purpose of fixing the ammonia, as it is said, in guano.

It is not my purpose to enter here into a discussion of the merits of salt or gypsum as fixers of ammonia, but I cannot help observing that both salt and gypsum are ill adapted for fixing any free ammonia in putrefying organic matters. I do not mean to speak disparagingly of the mixing of salt or gypsum with guano, for I believe this to be attended with very great benefit. The good effected by mixing guano with salt, however, I feel assured is not due to the salt fixing the ammonia in guano, as generally believed by practical men, and transcribed from one text-book on agricultural chemistry to the other; for in the first place salt is incapable of fixing any free ammonia in guano, and in the second place the amount of free ammonia in genuine Peruvian guano is so inconsiderable, that salt, even supposing it to fix ammonia, finds very little free ammonia in Peruvian guano upon which to exercise its supposed power of fixing ammonia.

A year or two ago Mr. Barrall, a French chemist, published some experiments, which purpose to prove the power of salt to fix ammonia in Peruvian guano, and to account thereby for the benefit which results from the mixing of guano with salt. I have carefully repeated Mr. Barrall's experiments, and shall publish the details of my analytical results shortly elsewhere; but, fearing I might be considered dogmatic in distinctly stating that salt is incapable of fixing free ammonia in guano, I beg to observe that I have been led to this conclusion by a series of experiments which are opposed in their results to Mr. Barrall's.

For the purpose of giving an idea of the actual quantity of free ammonia (carb. of ammonia) in Peruvian guano, I would mention in this place the following experiment:—A quantity of Peruvian guano, which on analysis gave the subjoined analytical results, was mixed with a little water, and distilled in a retort to dryness at a temperature not exceeding 212° F., and the distillate carefully collected in hydrochloric acid. On evaporation of the acid liquor in the receiver, sal ammoniac was obtained, from the weight of which that of ammonia volatilised with the watery vapours produced on distillation was calculated.

The following is the result of this determination. 100 parts of genuine Peruvian guano were found to yield ·573 of ammonia:—

Composition of Peruvian Guano used in this Experiment.

Moisture	12·78
* Organic matter and ammoniacal salts	53·08
Phosphates of lime and magnesia (bone-earth)	24·50
Alkaline salts	8·99
Insoluble silicious matter (sand)	·65
	100·00
* Containing nitrogen	13·18
Equal to ammonia	15·96

The same guano distilled with an excess of quicklime and some water, with a view of liberating the ammonia which existed in this sample of Peruvian guano in the form of ammoniacal salts, produced 6·931 of ammonia. Though we are in the habit of speaking of guano as an ammoniacal manure, it appears from these determinations that the smaller proportion of nitrogen is contained in Peruvian guano as ready-formed ammonia, and the larger proportion as uric acid, urea, and other nitrogenised compounds, which, however, in contact with water, are readily decomposed and yield ammonia.

The quantity of free ammonia and ammonia in the form of ammoniacal salts, of course, is not constant in different samples: I may state, however, that in dry genuine Peruvian guano I

never found a larger amount of free ammonia than ¾ per cent. This small proportion of free ammonia cannot excite surprise if the conditions are taken into account under which guano is deposited in the rainless regions from which good Peruvian guano is imported into this country. The dry and hot climate of the Peruvian guano islands has the effect of leaving very little free ammonia in the fresh birds' excrements, and of rapidly dissipating the moisture which they contain. With the expulsion of the moisture the further decomposition of the excrements is at once arrested, and the further development of ammonia prevented.

It follows from these remarks that as long as Peruvian guano is kept perfectly dry it may be preserved for any length of time without losing in the slightest degree in fertilising properties, and also that there exists no need of resorting to chemical substances which are known to possess the property of fixing ammonia.

The case is different with damaged and inferior descriptions of guano. These frequently contain considerable quantities of volatile carbonate of ammonia; they are therefore liable to become deteriorated on long keeping, and may be improved by the addition of an acid which fixes the free ammonia. Indeed, all guanos which are deposited in districts occasionally visited by heavy rains contain much carbonate of ammonia, a salt which in inferior guanos is often seen in beautiful large crystals, and which, being volatile, is gradually dissipated by keeping.

It has been stated already that there exists no necessity for fixing ammonia in farmyard manure by chemical means. But I refer again to this subject on account of a statement which has been widely circulated and been reported in most agricultural periodicals. It has been stated, namely, by a Mr. M'Dougall, the patentee of a disinfecting powder, that by the use of the patent article, not only the air in stables may be kept perfectly sweet and wholesome, but that also the quality of the dung is improved in an astonishing degree, so much so, that in the neighbourhood of Manchester fabulous prices have been paid for farmyard manure, in the preparation of which M'Dougall's powder has been used. I am bound to state at once, that this powder possesses, indeed, excellent disinfecting properties; and had the inventor confined his remarks to the sanitary question involved in the use of his powder, no room would have been left to call in question its utility as a disinfectant. But as he describes, in addition to its disinfecting properties, others which I have not found confirmed in my experiments on the subject, I am anxious to correct any erroneous views to which some of Mr. M'Dougall's statements may have given rise. It is maintained

by this gentleman that his disinfecting powder possesses the property of fixing ammonia in dung, and thereby rendering it more valuable than manure made in the ordinary manner. According to the published accounts, M'Dougall's powder consists chiefly of sulphite of lime and sulphite of magnesia, and contains also some carbolic acid in combination with lime, and free lime. It is said to be prepared by passing sulphurous acid into slaked lime, obtained on burning magnesian limestones, and by mixing with this product a certain quantity of crude carbolic acid, probably in the state of gas-tar.

The theory of the action of this disinfecting powder is described by the inventor in the following words:—

"The only agent we know which will decompose the noxious emanations from putrescent excreta, or other animal offal, without creating any detrimental action upon those elements which we wish to preserve, is sulphurous acid.

"Let us take two atoms of sulphuretted hydrogen, and one of sulphurous acid; when they are brought into contact, they are mutually decomposed, and form three of sulphur and two of water, both of which are entirely odourless. A similar reaction will ensue if we put phosphoretted hydrogen in the place of sulphuretted hydrogen, only the products would be two of phosphorus, one of sulphur, and two of water as before, both of which are also entirely odourless.

"Here, then, we have the means of solving the first condition of the problem. By the agency of sulphurous acid the offensive smell of putrescent substances may be removed. Further than this, sulphurous acid has a conservative action, which is highly favourable to our object. It has a strong affinity for oxygen, and will not permit other substances in its presence to combine with oxygen till its own affinity is satisfied. It thus exercises an influence highly anti-putrescent, besides decomposing the offensive compounds which have been already formed.

"We have another guarantee, however, for the prevention of putrefactive fermentation; this is the carbolic acid, which has the property of coagulating albuminous substances, and generally of preventing putrescence. As it is a liquid oily compound, we combine it with lime, and are thus enabled to dry it and reduce it to a powder, so rendering its application easy and simple.

"It only remains now that I explain the reason why we use magnesia in combination with the sulphurous acid. The reason is, that the compounds to be preserved are ammonia and phosphoric acid, and magnesia is the only available element which combines with them both and forms a triple compound, perhaps of all other possible combinations the best for agricultural purposes, viz. the triple phosphate of magnesia and ammonia.

"In the treatment of sewage or other similar matter in an advanced stage of decomposition, containing any considerable percentage of ammonia, we find it advantageous to add a soluble phosphate, as the quantity of phosphoric acid in the substances to be operated upon is not, in the circumstances, sufficient to permit the formation of the triple phosphate.

"Thus, then, we use sulphurous acid to remove the offensive smell, carbolic acid to prevent putrefactive fermentation, a little lime to neutralize and dry this latter acid, and magnesia to combine with and preserve the phosphoric acid and ammonia; and, in special cases, we add a soluble phosphate to prevent the loss of any of the ammonia."

These are Mr. M'Dougall's own words respecting the theory of the action of his disinfecting powder. The passage cited will be found (pp. 18, 19) in Mr. M'Dougall's pamphlet, entitled, 'On the Preservation of the Natural Manures, by Alexander M'Dougall. 1856.'

In page 20 of this pamphlet it is said—"Theoretically, it is perfect, leaving nothing to be desired; and in practice, it has not fallen short of the just expectations which were formed of its probable results in actual use."

I regret that I cannot share this opinion, for Mr. M'Dougall's powder is neither theoretically perfect, nor does it answer in practice the purpose for which it is recommended to the notice of agriculturists, for it is destitute of the property of fixing any free ammonia in liquid manure or in dung-heaps.

It is not my intention to criticise in detail Mr. M'Dougall's "perfect theory, which leaves nothing to be desired;" but I trust he will excuse me for reminding him that when two or more elements unite together chemically, a new compound substance is produced, which possesses properties not shared by its constituents. Thus sulphuric acid uniting with lime produces sulphate of lime, a combination in which neither the most striking characters of sulphuric acid nor of lime are any longer perceptible.

In the same manner sulphurous acid uniting chemically with lime produces a new compound substance, in which the most prominent features of lime and sulphurous acid have become permanently altered. Unless it can be shown experimentally that the action of sulphurous acid in combination with lime and magnesia upon sulphuretted or phosphoretted hydrogen is the same as that of free sulphurous acid, Mr. M'Dougall's attempted explanation of the action of the disinfecting powder upon sulphuretted and phosphoretted hydrogen must indeed be regarded as a theory—a theory, however, which I imagine every sound chemist will more likely call a wild than a perfect one. M'Dougall's powder possesses the power, though only in a slight degree, of removing sulphuretted hydrogen from liquids. This property it owes not to the sulphite of lime or magnesia which it contains, but, as it appears to me with much greater probability, to the free lime which enters into the composition of M'Dougall's powder.

In order to decide positively this point, the following experiment was made:—

To a strong and clear solution of M'Dougall's powder in water a small quantity of sulphuretted hydrogen water was added; the smell disappeared, no deposit of sulphur was produced. Some more sulphuretted hydrogen water was added to

the same liquid; a strong smell of sulphuretted hydrogen remained, and no deposit whatever of sulphur was produced.

The solution of the disinfecting powder in water had a distinct alkaline reaction, and contained, as ascertained by direct experiment, in addition to sulphite of lime and sulphite of magnesia, some quick lime.

Lime-water, *i.e.* a solution of quick lime in water, I find possesses the property of removing sulphuretted hydrogen from its solutions to a larger extent than a solution of M'Dougall's powder; whilst a solution of pure sulphite of lime and magnesia apparently does not possess the power of removing sulphuretted hydrogen from its solution. At any rate, even a concentrated solution of sulphite of lime or sulphite of magnesia, added in large excess to a solution of sulphuretted hydrogen, produces no deposit of sulphur, and has no immediate effect upon this gas.

Having proved experimentally that it is not the sulphite of lime or magnesia in M'Dougall's disinfecting powder, but in all probability the free-lime contained in it, which instantly removes sulphuretted hydrogen from its solutions in water, I will next describe some experiments which I have made in conjunction with Mr. Coleman, our farm-manager, with a view of testing the disinfecting properties of this powder.

The fact that refuse gas-lime contains sulphurous acid in combination with lime, as well as free lime, induced me to compare the effects of M'Dougall's powder with dried and finely powdered gas-lime, to which a small quantity of gas-tar was added. By incorporating some gas-tar with the refuse lime of gas-works, previously dried and powdered, a product is obtained which smells very similar to M'Dougall's powder, and resembles the latter closely in its general appearance; and also so far in composition, as it contains likewise sulphite of lime, free lime, and carbolic acid. The proportion of caustic lime in this prepared gas-lime, however, was much more considerable than in M'Dougall's powder, which no doubt accounts for the fact that this sample of prepared gas-lime greatly excelled the newly-invented powder in deodorizing properties.

It appeared to me also desirable to mix slaked lime with a little gas-tar, and to try this mixture simultaneously with the two other powders in the stable.

With these three powders the following experiments were made :—

1st *Set of Experiments.*

Three loose boxes were cleared out and respectively sprinkled with M'Dougall's powder, prepared gas-lime and tar, and with slaked lime and tar.

All animal smell was instantly removed in each of the three boxes, but there remained a faint but perceptible smell of ammonia in the first box, sprinkled with M'Dougall's powder. In the second box, sprinkled with gas-lime, the smell of ammonia was still more distinct; and in the third box, sprinkled with slaked lime, the smell of ammonia was most marked.

It thus appears from these experiments that whilst all three powders removed instantly the peculiar animal smell which prevails in stables, none possessed the power of fixing free ammonia.

In the experiment with M'Dougall's powder the smell of ammonia was masked by the tarry products contained in this powder to an extent which rendered it difficult to an inexperienced person to recognise by the smell alone the presence of free ammonia. On the other hand, the smell of ammonia in the third loose box was decidedly stronger after sprinkling the floor with slaked lime and tar than before the experiment. As M'Dougall's powder contains only little caustic lime, the prepared lime a good deal more, and the slaked lime most caustic lime, it is evident that the differences in this respect are mainly due to the relative quantities of caustic lime present in the three experimental powders. The experiment with slaked lime, moreover, shows that the excrementitious matters on the floor of stables contain ammoniacal salts, from which ammonia is liberated by caustic lime.

2nd Set of Experiments.

Some of M'Dougall's powder was next added to fresh farmyard manure. The peculiar animal smell of the latter was rapidly removed, but ammonia—it is true, in small quantities, but still in a perceptible degree—liberated at the same time.

An equal portion of fresh farmyard manure was treated with prepared gas-lime, and a third portion of fresh dung with slaked lime and gas-tar.

The two last-named powders rapidly destroyed the disagreeable animal smell of the dung, and, like M'Dougall's powder, liberated some ammonia.

Similar experiments were tried with three equal portions of well rotten dung with similar results. In each case ammonia was given off in small quantities, especially in the experiment in which slaked lime was added to rotten dung.

In order to leave no doubt on the fact brought out by our experiments on fresh and rotten dung, namely, that M'Dougall's powder, instead of fixing ammonia, actually liberated ammonia from its combinations, the following experiments were made:—

A portion of rotten dung was put into a wide-mouthed bottle, in the neck of which a moistened red litmus paper was

inserted. At the same time an equal quantity of rotten dung was put into a second bottle, and some of M'Dougall's powder was well mixed with the dung. The animal smell, as before, was completely removed. In the neck of the second bottle a red litmus paper was inserted. In the course of a few minutes the litmus paper in contact with the air surrounding the deodorized dung was distinctly turned blue, whilst the paper in the first bottle retained its original red colour, thus proving clearly that the dung which contains no free ammonia, when deodorized with M'Dougall's powder, gives off ammonia in a perceptible degree.

I have shown in numerous experiments that the amount of ammonia which may be obtained by treating farmyard manure with quick lime is but small; unmixed with any other animal emanations, when gradually liberated by a powder which, like M'Dougall's, contains only little caustic lime, and masked by the smell of tar, the ammonia in dung is hardly perceptible by the smell. And as many people refer the smell of dung to ammonia, forgetting that the peculiar putrescent smell of dung is principally due to other animal exhalations, I can readily understand the mistaken idea which no doubt many entertain who have practically tested the effects of this disinfecting powder upon dung. But let them try the effect of M'Dougall's powder upon a solution of sal-ammoniac or sulphate of ammonia, and they will find, without difficulty, that it liberates from these inodorous salts the pungent-smelling ammonia. Or, by mixing a moderate quantity of the powder with a manure which, like guano, contains a large proportion of ammoniacal salts, it may be shown that M'Dougall's powder contains a constituent, the chemical effect of which manifests itself by the copious discharge of ammonia.

3rd Set of Experiments.

In a third series of experiments I have studied the disinfecting properties of M'Dougall's powder in relation to liquid manure.

With a view of ascertaining what share the sulphite of magnesia and sulphite of lime had in the deodorizing effect upon liquid manure, and what share the free lime contained in the powder, I prepared a pure and concentrated solution of sulphite of lime and sulphite of magnesia, the effects of which were tried upon liquid manure.

For other experiments I used a solution of gas-lime, prepared as described above, and I also tried the effects of slaked lime mixed with some coal-tar.

Finally, I saturated the free lime in M'Dougall's powder, by passing into it sulphurous acid as long as it was absorbed, and

removed the excess of this gas by drying the powder at a very moderate heat.

With these various materials, the following experiments were instituted:—

1. Added to 6 ounces of liquid manure 2 ounces of a strong solution of sulphite of magnesia and sulphite of lime. No apparent effect was produced. Added 2 more ounces of the same solution. The smell remained unchanged.

By keeping this mixture of liquid manure with sulphite of magnesia and lime, for three weeks in a bottle, the original disagreeable smell of the liquid manure remained unaltered, thus showing that pure sulphites have not the power of removing the bad smell from putrescent liquids.

2. 50 grains of M'Dougall's powder were finely pounded in a mortar, and gradually mixed with 5 ounces of liquid manure. The bad smell of the latter disappeared instantly. An addition of 5 ounces more of liquid manure; the liquid became sweet to the smell after a few minutes. 10 additional ounces were next mixed with the disinfected liquid, and thus altogether 20 ounces of liquid manure were mixed with 50 grains of M'Dougall's powder.

After some time the bad smell disappeared altogether, but, at the same time, ammonia was set free, as shown by litmus paper suspended in the neck of the bottle.

3. The same experiment was tried, with the substitution for M'Dougall's powder of 50 grains of prepared gas-lime.

The result was similar to that obtained in the second experiment; the only perceptible difference being that, by using gas-lime, the liquid manure, which had originally a dark greenish brown colour, was rendered more transparent and lighter coloured than by using M'Dougall's powder.

4. Another experiment was tried with 20 ounces of liquid manure and 50 grains of slaked lime, mixed with some gas-tar.

The putrescent smell was instantly removed, and the liquid became bright and colourless like water. Ammonia was given off.

5. ¼ lb. of M'Dougall's powder was treated with 20 ounces of distilled water, and filtered.

The clear liquid was coloured yellow, smelt like the powder, and had a weak alkaline reaction.

4 ounces of this solution were mixed with 4 ounces of liquid manure; the bad smell disappeared after some time. 4 ounces more of liquid manure were added; the smell was not entirely removed.

Kept in a bottle for 2 days, the liquid was not entirely deodorized.

6. ¼ lb. of prepared gas-lime was treated with 20 ounces of distilled water. The clear liquid filtered from the insoluble matter was yellow-coloured, and smelt similar to the solution of M'Dougall's powder. It possessed a stronger alkaline reaction than the solution of M'Dougall's powder.

By mixing 8 ounces of liquid manure with 4 ounces of this solution of gas-lime a considerable deposit was produced, the liquid became much clearer and brighter, and lost all disagreeable smell.

7. 6 ounces of liquid manure were mixed with 20 grains of M'Dougall's disinfecting powder.

The colour of the liquid became lighter, ammonia was liberated, and the peculiar disagreeable odour of liquid manure completely removed after some time.

8. 6 ounces of liquid manure were mixed with 20 grains of M'Dougall's powder, previously saturated with sulphurous acid.

The colour of the liquid remained unaltered, and the smell remained as bad as before the addition of the powder.

If the deodorizing effects of the disinfecting powder were due to the sulphite of magnesia contained in it, the deodorizing effect of the powder when saturated with sulphurous acid, it is plain, should have become more marked; but the contrary was the case. Indeed, by neutralizing the free alkaline constituents in the powder its deodorizing power was destroyed.

9. It is but fair to state that Mr. M'Dougall recommends the addition of a soluble phosphate to liquids containing much free ammonia. He mentions liquid manure and sewage as two liquids which do not contain sufficient phosphoric acid in a soluble form to unite with all the ammonia contained in these liquids and the magnesia of the disinfecting powder. Following his advice, I added to liquid manure phosphate of soda, in various proportions, and used small and large doses of the disinfecting powder. In every instance M'Dougall's powder failed to fix the ammonia in liquid manure, notwithstanding the presence of abundance of soluble phosphates.

It thus appears from these various experiments:—

1. That M'Dougall's powder is unfit to fix any ammonia in dung.

2. That its deodorizing effects are not due to the sulphite of magnesia or sulphite of lime, but to the alkaline constituents which it contains.

3. That, instead of fixing ammonia, it liberates, like all alkaline matters, ammonia from its combinations.

It is well known, however, that animal excrementitious matters, when deodorized by lime, after some time give off again

a disagreeable odour; and it is very likely that sulphite of magnesia and sulphite of lime, on account of their great affinity for oxygen, will prevent this evil by stopping the further decomposition of animal matters deodorized by lime. Considered in a purely sanitary point of view, M'Dougall's powder may therefore possess advantages over quick lime as a disinfectant. Still it is difficult to conceive how such a farther decomposition can be arrested practically by the use of this powder, for it appears to me that this can only be realized by the employment of so large a quantity of powder as to render the process altogether too expensive.

Drainings of Dung-heaps.—Nobody can deny that farmyard manure is seldom kept in the most efficient manner. In many places in England, especially in Devonshire and in some parts of Gloucestershire, it is a common practice to place manure-heaps by the roadside, often on sloping ground, and to keep these loosely-erected heaps for a considerable length of time before carting the dung on the field. On other farms, the manure is allowed to remain loosely scattered about in uncovered yards for months before it is removed. Heavy showers of rain falling on manure kept in such a manner, by washing out the soluble fertilizing constituents of dung, necessarily greatly deteriorate its value. It is well known that the more or less dark-coloured liquids which flow from badly-kept dung-heaps in rainy weather possess high fertilizing properties. According to the rain which falls at the time of collecting these drainings, according to the character of the manure, and similar modifying circumstances, the composition of the drainings from dung-heaps is necessarily subject to great variations. The general character of these liquids, however, is the same in dilute and in concentrated drainings. Several samples of dung-drainings were recently examined by me, and, from their analyses, it will be seen that they contain a variety of fertilizing constituents which it is most desirable to retain in dung-heaps.

The first liquid examined was collected from a dung-heap composed of well-rotten horse-dung, manure from fattening beasts, and the dung from sheep-pens. Both the horse-dung and dung from fattening beasts were made in boxes. The liquid which ran from this dung-heap was collected in rainy weather, and contained, no doubt, in addition to the liquid portion of the dung, a good deal of rain.

The colour of this liquid was dark brown; it contained no free sulphuretted hydrogen, nor any free ammonia. Its reaction was neutral to test-paper, but on boiling it became alkaline, ammonia being given off freely. Besides ammonia, boiling expelled a very considerable quantity of carbonic acid, which is

contained in drainings of dung-heaps, partly in mechanical solution, but chiefly in the form of bi-carbonates ; these, on boiling, are decomposed into neutral carbonates, and into carbonic acid, which escapes.

On addition of hydrochloric acid the liquid strongly effervesced and gave off a most disgusting stench. Notwithstanding the disagreeable odour produced, on adding hydrochloric acid to these drainings of a dung-heap, there was no sulphuretted hydrogen in the mixed gases which escaped. The acidulated liquid being heated deposited in abundance a dark brown flaky substance, which was afterwards identified as a mixture of humic and ulmic acids. The deposition of these organic acids in the shape of a brown flaky mass had the effect of leaving the supernatant liquid merely pale yellow. It is thus plain that the dark brown colour of drainings of dung-heaps is due to compounds of humic and ulmic acids. These compounds are easily decomposed by mineral acids, and as the dark-coloured organic acids, which separate, in a free state are nearly insoluble in water, the original dark brown liquid is decolourized.

Humic and ulmic acid are both products of the decay of carbonaceous organic matters, and their abundance in the drainings of dung-heaps is easily explained by the decomposition of the straw and the non-nitrogenized constituents of excrementitious matters. In combination with potash, soda, and ammonia, humic and ulmic acids form dark-coloured, readily-soluble salts; whilst with lime, magnesia, and earthy and metallic bases the same organic acids form compounds insoluble in water.

The dark brown colour of the drainings therefore is an indirect proof of the existence in them of potash, soda, or ammonia. The subsequent examination indeed has afforded the direct proof that drainings of dung-heaps contain all three alkalies, combined at least in part with organic acids, which being found in large quantities in humus may be called by the generic name of humus-acids.

Chemists are well acquainted with the fact that with the degree of heat to which chemical agents are exposed their affinities one towards the other are changed. Thus, for instance, at the ordinary temperature of the atmosphere, or at the heat of boiling water, sulphuric acid is capable of separating phosphoric acid from bone-earth, and forming with the lime of the latter sulphate of lime or gypsum. But when a mixture of sulphate of lime and phosphoric acid is heated to redness, the affinities between lime and phosphoric and sulphuric acid are changed. A reverse action to that which takes place at a comparatively low temperature manifests itself, and, provided the temperature is sufficiently elevated and enough phosphoric acid present, all

sulphuric acid is driven out from the gypsum, and phosphoric acid takes its place.

Similar chemical reactions, dependent on changes of temperature, are continually taking place in dung-heaps in an active state of fermentation, as well as called into play by heating drainings of dung-heaps.

I have kept for days a reddened litmus-paper inserted into the neck of a bottle, in which such drainings were placed, without perceiving the slightest change in the colour of the paper, thus proving distinctly that these drainings do not contain a trace of free ammonia. But when the temperature of the drainings is slightly elevated ammonia is given off at once, and continues to escape as long as the liquid is kept boiling, and a good deal of water is left in the vessel in which the liquid is boiled. For this reason it is necessary in determinations of free ammonia in this and similar liquids containing humus-acids, to continue the process of distillation until the liquid is nearly evaporated to dryness. In boiling the drainings of dung-heaps the volatilization of ammonia is accompanied by the deposition of flakes of humic and ulmic acids, as well as carbonate of lime, held in solution by carbonic acid, which in boiling is likewise expelled.

It thus appears that although the affinity of humus acids for ammonia is sufficiently strong completely to prevent its escape at the ordinary temperature, it suffers a change at a slightly elevated temperature, in consequence of which ammonia escapes. Drainings of dung-heaps contain in solution bi-carbonate of lime, which, at the ordinary temperature of the air, has no effect upon humate and ulmate of ammonia; on heating, the bi-carbonate of lime loses carbonic acid, and becomes neutral carbonate of lime, a combination which is capable of decomposing humates and ulmates of ammonia. The ulmic and humic acid of the latter uniting with the lime, with which they form insoluble compounds, leave the ammonia in a free state, and on boiling of liquid it gradually evaporates with the watery vapours.

The examination of the chemical constitution of the drainings of dung-heaps thus leads at once to the explanation of the reason why hot dung has a pungent smell, caused by the escape of ammonia, and why even rotten dung when cold does not give off any free ammonia. In relation to the amount of ammonia farmyard manure always contains a great excess of these humus acids, hence the free ammonia proceeding from the interior portions of dung-heaps, which are in an active state of fermentation, is arrested by the humus substances contained in the cold external layers of dung-heaps. In contact with air any undecomposed

straw is gradually changed into these excellent fixers of ammonia, and thus a natural provision is made in dung-heaps to prevent the loss of ammonia.

Drainings of dung-heaps present us with another interesting chemical particular, which at first sight appears quite anomalous, but which finds a ready explanation in the peculiar composition of these drainings and the properties of humus and ulmic acid. Drainings of dung-heaps, namely, present us with a liquid which, though perfectly neutral to test-paper, may be mixed with a certain quantity of acid without becoming in the slightest degree acid. This will appear from the following experiment:—7000 grains of perfectly clear, dark-brown coloured and neutral drainings were mixed with 50 drops of concentrated hydrochloric acid; the liquid strongly effervesced, gave off a horrid smell, and deposited a considerable quantity of a brown, flaky substance. The supernatant liquid was much paler, and produced no change on litmus paper.

A single drop of concentrated hydrochloric acid added to 7000 grains of distilled water was readily detected by turning blue litmus paper distinctly red, thus proving that the test-paper was sufficiently delicate to detect the presence of a very small quantity of free acid.

A further addition of 50 drops of concentrated hydrochloric acid to the same drainings produced a decided acid reaction, and caused the separation of a little more flakulent matter.

The whole of the brown flaky substance was collected in a weighed filter, dried at 212° Fahr., and weighed, and found to amount to 12·55 grains.

An imperial gallon of these drainings accordingly contained 125·5 grs. of humic and ulmic acids.

If it be remembered that these organic acids are insoluble in water, and are contained in the drainings in combination with alkalies, the curious circumstance that an acid may be added to neutral drainings without producing an acid reaction will be readily understood. The first quantity of hydrochloric acid had the effect of uniting with the alkalies, and it thus became neutralized, whilst the organic humus acids previously in union with the alkalies of the drainings were separated, and, being insoluble in water, of course could not affect litmus paper.

I have determined also in the same drainings the amount of carbonic acid which is expelled by simply boiling this liquid, and found in one imperial gallon of drainings 88·20 grains of carbonic acid, which is thus loosely united with the liquid.

The amount of free ammonia (ammonia expelled on boiling the liquid) in these drainings was determined in the manner

described above; and after the free ammonia was removed, quick lime was added to the remainder of the concentrated liquid for the purpose of separating any ammonia present in the form of salts, which are not decomposed simply by boiling.

In this way the following results were obtained:—

One imperial gallon of drainings contained 36·25 grains of free ammonia and 3·11 grains of ammonia in the form of salts, not decomposed simply on boiling, but by continued boiling with quick lime.

Evaporated to dryness, 7000 grains furnished 62·51 grains of solid matters, dried at 212° Fahr.; or one imperial gallon was found to contain 625·10 grains of solid matters. On heating to redness, 62·51 grains left 36·89 grains of ash. This ash was submitted to a detailed analysis, and calculated for one imperial gallon of the drainings.

According to the analytical results obtained in these different determinations, an imperial gallon of these drainings contained—

Volatile and combustible constituents		395·66		
Viz.	Ammonia driven out on boiling	36·25	Together. 39·36	
	Ammonia in the state of salts decomposed by quick lime	3·11		
	Ulmic and humic acid		125·50	
	Carbonic acid, expelled on boiling		88·20	
	Other organic matters (containing 3·59 of nitrogen)		142·60	
				395·66
Mineral matters (ash)		368·98		
Viz.	Soluble silica		1·50	
	Phosphate of lime, with a little phosphate of iron ..		15·81	
	Carbonate of lime		34·91	
	" magnesia		25·66	
	Sulphate of lime		4·36	
	Chloride of sodium		45·70	
	" potassium		70·50	
	Carbonate of potash		170·54	
				368·98
	Total per gallon			764·64

These analytical results suggest the following remarks:—

1. It will be seen that these drainings contain a good deal of ammonia, which should not be allowed to run to waste.

2. They also contain phosphate of lime, a constituent not present in the urine of animals. The fermentation of the dung-heap thus brings a portion of the phosphates contained in manure into a soluble state, and enables them to be washed out by any watery liquid that comes in contact with them.

3. Drainings of dung-heaps are rich in alkaline salts, especially in the more valuable salts of potash.

4. By allowing the washings of dung-heaps to run to waste, not only ammonia is lost, but also much soluble organic matter, salts of potash and other inorganic substances, which enter into the composition of our crops, and which are necessary to their growth.

II. *Drainings from another Dung-heap.*

These drainings were not so dark-coloured as the preceding ones. Like the former liquid, it was neutral, but gave off ammonia on boiling and on addition of quick lime.

Hydrochloric acid produced a dark-brown coloured flaky deposit, leaving the liquid only pale yellow.

The amount of the precipitated humus acids was much smaller than in the preceding liquid.

For want of a sufficient quantity of liquid, only the amount of solid matter contained in it could be determined.

An imperial gallon on evaporation furnished 353·36 grains of solid matter, dried at 212° Fahr.

III. *Drainings from a third Dung-heap.*

A dung-heap, composed chiefly of mixed fresh horse, cow's or pig's dung, furnished the material for the third analysis of drainings.

This liquid was much darker than the two preceding liquids, possessed an offensive smell, although it contained no sulphuretted hydrogen. It was neutral to test-paper, consequently did not contain any free or carbonate of ammonia. On heating, ammonia escaped, apparently, however, in much smaller quantities than from the preceding drainings.

This liquid was collected at a time when no rain had fallen for several weeks, which circumstance accounts for its greater concentration. It was submitted to the same course of analysis as the first drainings.

7000 grs. evaporated to dryness produced 135·774 grs. of dry matters; and this quantity, on burning in a platinum dish, furnished 62·58 grs. of mineral matters. A separate portion was used for the determination of the amount of ammonia present in the form of salts; and another portion of liquid, acidulated with a little hydrochloric acid evaporated to dryness, was employed for the determination of the whole amount of nitrogen.

By deducting the amount of nitrogen found in the ammoniacal salts from the total amount of nitrogen obtained by combustion of the solid matter with soda-lime, the proportion of nitrogen contained in the organic substances of these drainings was ascertained.

The following Table represents the composition of the solid

substances found in one imperial gallon of drainings from fresh manure:—

Composition of Solid Matters in one Gallon of Drainings from Fresh Farmyard Manure.

Ready-formed ammonia (principally present as humate and ulmate of ammonia) ..	15·13
* Organic matters	716·81
* * Inorganic matters (ash)	625·80
Total amount of solid matter in one gallon of drainings	1357·74
Containing nitrogen	31·08
Equal to ammonia..	37·73
* * 625·80 of ash consisted of:—	
Silica	9·51
Phosphates of lime and iron	72·65
Carbonate of lime	59·58
Sulphate of lime	14·27
Carbonate of magnesia	9·95
,, potash	297·38
Chloride of potassium	60·64
,, sodium	101·82

It will be observed that these drainings contain about double the amount of solid matter which was found in the liquid from the first heap. The composition of this solid matter compared with that of the solid matter in the liquid from the first heap, moreover, presents us with some particulars to which it may be advisable briefly to allude.

In the first place I would remark that notwithstanding the greater concentration of the third liquid, as compared with the first, the proportion of ammonia present in the form of ammoniacal salts is less than one-half; for whilst the first drainings contained in the gallon 39 grs. of ready-formed ammonia in round numbers, the third drainings contained only 15 grs. per gallon.

It thus appears that drainings from manure-heaps in an advanced stage of decomposition contained, as may be naturally expected, a larger proportion of ready-formed ammonia than the liquid which flows from heaps composed of fresh dung. It is further worthy of notice that the first drainings contained nearly all the nitrogen in the form of ammoniacal salts, whilst the drainings from fresh dung contained the larger proportion of this element in the form of soluble organic substances. The most important constituent of farmyard manure, *i.e.*, nitrogen, thus is liable to be wasted in the drainings, whether they proceed from rotten or fresh manure, for in either case it passes off in a soluble state of combination.

Whilst speaking of the nitrogen in the drainings of dungheaps I ought to mention that in both the liquids examined in detail I

have detected readily the presence of nitric acid. In the liquid from fresh manure there were apparently mere traces of nitrates, but in that from rotten dung the proportion of nitric acid was so considerable that I hoped to be able to determine it quantitatively. But I found the large amount of soluble organic matter to interfere sadly with the nitric acid determination; and, unable to supply for the present correct results, I merely mention the fact that these liquids contained nitrates, and trust to be able to supply this deficiency in these analyses at a future period.

In the next place I would observe that the proportion of organic and inorganic matters bear to each other a different relation in the first and in the third liquid.

In the liquid from rotten dung the proportion of mineral matter exceeds that of organic substances, and in the third liquid the reverse is the case. We learn from this that soluble organic matters are very liable to become decomposed; and it is not unlikely that all putrescent organic matters before assuming a gaseous state are first changed into soluble matters.

In the first stage of decomposition, *i.e.*, during the active fermentation of dung, the constituents of farmyard manure are rendered more and more soluble; hence, up to a certain point the amount of soluble organic matters increases in manures. But when active fermentation in manure heaps becomes gradually less and less energetic, and finally ceases, the remaining fermented manure is still liable to great and important changes, for it is subject to that slow but steady oxidation, or slow combustion, which has been termed, appropriately, by Liebig, Eremacausis. To this process of slow oxidation all organic substances are more or less subject. It is a gradual combustion, which terminates with their final destruction.

Hence the larger proportion of organic matter in the liquid from the manure heap formed of fresh dung, in an active state of fermentation, and the smaller proportion of organic matter in the drainings of the first heap, in which the dung had passed the first stage of decomposition, and been exposed for a considerable period to the subsequent process of eremacausis, or slow combustion.

The formation of nitric acid from putrefying organic matters has long been observed, but the exact conditions under which it proceeds are by no means satisfactorily established, and much room is left to further extended investigations.

The mineral substances in the drainings from fresh dung are the same as those from rotten. Like the ash of the latter, the liquid from fresh dung-heaps contains soluble phosphates, soluble silica, and is rich in alkaline salts, especially in carbonate of potash, of which there are nearly 300 grs. in a gallon of the liquid.

Sufficient evidence is thus presented in the analyses of these liquids, that, as the drainings of both fresh and rotten dung-heaps are allowed to flow into the next ditch, concentrated solutions of the most valuable constituents of dung are carelessly wasted.

With a view of preventing such a serious loss, I have suggested the propriety of carting the manure on the fields, whenever practicable, in a fresh state, and of spreading it at once. It may be objected that the application of manure in a fresh state, equivalent to winter manuring, and especially the spreading of dung, will lead to waste, inasmuch as the rain which falls during the winter and spring has much more chance of washing out fertilizing substances from dung than by applying it at the time of sowing. This objection would indeed be a valid one, if we were not acquainted with the fact that all soils containing a moderate proportion of clay possess the property of retaining the more valuable constituents of manure; but, this being the case, the objection on these grounds cannot be admitted. With more force, however, it may be made with reference to light sandy soils, and it is indeed upon such soils that manure is best applied in spring.

I would remind the reader of the interesting and important observations of Mr. Thompson with respect to the property of soils of absorbing manuring matters,* and beg to refer him to the highly important investigations of Professor Way on the same subject. The papers of Professor Way on this subject are full of interest; they embody highly important results, and constitute most valuable contributions to our agricultural literature. A careful perusal of these papers will afford strong evidence that soils not merely possess the power of absorbing and retaining gaseous ammonia, but that they also have the property of separating this fertilizer, as well as potash and other manuring matters, from their soluble combinations.

Professor Way principally operated with simple salts, and it may therefore be urged, with some plausibility, that, in the case of a highly complex mixture of soluble substances, such as that presented in the liquid portion of manure, changes may take place in the soil which lead to a waste of manure, when applied long before the crop is sown which it is intended to benefit. Thus it may be urged that it by no means follows that because a soil absorbs ammonia when a solution of sulphate of ammonia is passed through it, the same absorption will take place when an ammoniacal salt, mixed with some dozen of other substances, is passed through it.

* Journal, vol. xi. p. 68.

Fully impressed with the force of such an argument, I was anxious to determine, by direct experiments, the changes which liquids like the drainings of dung-heaps and liquid manure undergo when brought into contact with soils, and to ascertain at the same time to what extent soils of known composition possessed the power of absorbing manuring matters from such complex liquids. It is hardly necessary to observe that the results to which the experiments to be described presently have led, apply not merely to the liquids experimented with, but extend to compound manuring matters in general and to farmyard manure in particular, for the drainings of dung-heaps may, indeed, be regarded as the very essence of dung. The deductions which can be legitimately drawn from my experiments, therefore, apply in a special manner to farmyard manure.

In order to ascertain to what extent various soils possessed the power of absorbing manuring constituents from the drainings of dung-heaps, I determined to employ a limited quantity of soil and a large excess of liquid. To this end, 2 parts by weight of liquid were well mixed with 1 part by weight of soil, and left in contact with the latter for 24 hours, after which the clear liquid was drawn off and passed through a filter.

Experiments to ascertain the Extent of Absorbing Properties of Soils of known Composition.

1. *Experiment made with the Drainings of Dung-heaps composed of rotten Dung.*—The drainings employed in this experiment were the same which contained in the imperial gallon 664·64 grains of solid matters, the detailed composition of which is given above. The composition of the soil used in the experiment is given below.

The surface-soil contained a good deal of organic matter, a fair proportion of clay, little sand, and a moderate proportion of carbonate of lime in the form of small fragments of limestone. It was a stiffish soil, belonging to the clay-marls. Its subsoil was richer in clay and of a more compact texture and less friable character than the surface-soil. The mechanical analyses of soil and subsoil gave the following results:—

	Surface-soil.	Subsoil.
Moisture when analysed	5·36	3·66
Organic matter and water of combination ..	25·86	8·79
Lime	14·30	26·03
Clay	34·84	56·76
Sand	19·64	4·76
	100·00	100·00

In the chemical analysis of this soil the following results were obtained :—

	Surface-soil.	Subsoil.
Moisture when analysed	5·36	3·66
Organic matter and water of combination ..	25·86	8·79
Oxides of iron and alumina	13·88	10·13
Carbonate of lime	14·30	26·03
Sulphate of lime	·56	Not determined.
Phosphoric acid and chlorine	traces	
Carbonate of magnesia	1·04	
Potash	·07	1·67
Soda	·18	
Insoluble siliceous matter	38·75	49·73
	100·00	100·00

2000 grains of this soil and 2000 grains of subsoil were mixed with 4000 grains of the liquid from rotten dung. After 24 hours the clear liquid was carefully drawn off and filtered. Its original dark brown colour was changed into a pale yellow colour. This soil thus possessed in a high degree the property of decolourizing dark-coloured liquids like the washings of dung-heaps.

1200 grains of the filtered liquid, passed through soil, were distilled in a retort nearly to dryness, and the ammonia which was given off carefully collected in an apparatus containing hydrochloric acid, and so constructed as to secure the perfect absorption of ammonia.

The amount of chloride of ammonium obtained on evaporation of the acid liquid in the receiving-vessel was ·62 grains. This gives for 1 imperial gallon of liquid passed through soil 11·49 grains of ammonia.

Originally the drainings contained, per gallon	39·36
After filtration through soil they contained, per gallon	11·49
Absorbed by 70,000 grains of soil	27·87 amm.

1000 grs. of this soil thus absorbed ·396 of ammonia.

On evaporation of another portion of the same liquid passed through soil, 1 imperial gallon of filtered drainings was found to contain :—

164·88 of organic matter.
210·20 of inorganic matter.

Before filtration through soil, the imperial gallon contained :—

268·10 grains of solid organic substances.
368·98 of mineral matters.

A considerable quantity of both organic and mineral matters thus was removed from the liquid in contact with the soil.

b. A similar experiment was made by diluting 4000 grains of

the same drainings with 4000 grains of distilled water, and leaving this more dilute liquid in contact for 24 hours with 2000 grains of the same soil and 2000 of subsoil.

The filtered liquid contained in the gallon :—

Ammonia	6·91
Organic matters	118·50
Mineral matters	147·36
Total amount of solid matters in gallon ..	272·77

The 147·36 of mineral matters (ash) consisted of—

Silica	2·38
Phosphates of lime and iron	1·54
Carbonate of lime	79·72
,, magnesia	6·17
Sulphate of lime	7·92
Chloride of sodium	18·90
,, potassium	26·44
Carbonate of potash	4·29

Originally the liquid employed in this experiment contained 19·68 grains of ammonia to the gallon. After passing through half its weight of soil it contained only 6·91 grains of ammonia. Consequently 12·77 were retained by 35,000 grains of soil, and 1000 grains of soil absorbed ·365 grains of ammonia.

This result, it will be seen, agrees closely with the first experiment, in which undiluted drainings were used, and ascertained that 1000 grains of the same soil absorbed ·396 grains of ammonia.

In both instances it was thus found that rather more than two-thirds of the amount of ammonia present in these drainings in the form of ammoniacal salts were retained by a very limited quantity of soil.

I have purposely used a large amount of liquid in comparison with that of soil. If, under such conditions, the soil is capable of retaining two-thirds of the whole amount of ammonia present in a liquid like the one examined, it is not too much to expect that no ammonia whatever will be lost in practice by carting manure on the fields in autumn and spreading it at once. The quantity of soluble ammoniacal matters in a heavy dressing of the best dung does not amount to many pounds, and such a quantity, in relation to the weight of the soil ready to take up ammonia from the manure, is so insignificant that the most scrupulous may rest satisfied that in a soil containing even a small proportion of clay no ammonia will be lost by dressing the fields in autumn.

Other no less important changes than those referring to the absorption of ammonia will strike the reader to have taken place in these drainings left in contact with the soil.

For better comparison's sake, I will give the composition of the drainings before and after passing through soil, and then make a few additional remarks which are suggested by such a comparison.

Composition of Drainings from Rotten Dung.

1 imperial gallon contains—

	Before Filtration through Soil.	After Filtration through Soil.
Ammonia (in the form of ammoniacal salts)	19·68	6·91
Organic matters	134·05	118·50
Silica	·75	2·38
Phosphates of lime and iron	7·90	1·54
Carbonate of lime	17·46	79·72
Sulphate of lime	2·18	7·92
Carbonate of magnesia	12·83	6·17
Chloride of sodium	22·85	18·90
" potassium	35·25	26·44
Carbonate of potash	85·27	4·29
	338·22	272·77

It will be observed that this liquid, in passing through the soil, has undergone a striking change. Leaving unnoticed several minor alterations in the composition of the original liquid, I would direct special attention to the very small proportion of carbonate of potash left in the drainings after contact with this soil. It will be seen that, out of 85 grains of potash contained in the original liquid, no less than 81 grains have been retained by the soil. This is a result of the greatest importance, inasmuch as it shows that the soil possesses, in a remarkable degree, the power of removing from highly-mixed manuring substances not only ammonia from ammoniacal salts, but also the no less important soluble potash compounds. According to this result, 1000 grains of soil absorb no less than 2·313 grains of carbonate of potash. But, in addition to carbonate of potash, a considerable quantity of chloride of potassium is retained in this soil by passing the washings from rotten dung through it: for it will be observed that nearly 9 grains of this salt, or, in exact numbers, 8·81, were retained in the soil. The avidity of the soil for soluble salts of potash is the more remarkable, as it offers a striking contrast to the apparent indifference of this soil to absorb soda from its soluble combinations; for it will be seen that the liquid, after filtration through the soil, contains only about 4 grains less of common salt in the gallon than before filtration.

In a purely chemical point of view, soda salts are closely allied to salts of potash, and yet there is a marked difference observable in the power of this soil, at least, to absorb the one or the other alkali.

As regards the practical effect which salts of soda and potash are capable of displaying with reference to the nutrition of plants, the former are not to be compared to the latter in point of efficacy. It was believed at one time that soda was capable of replacing potash in the ashes of our crops, but this opinion was not based on trustworthy evidence. On the contrary, the best and most extensive series of ash analyses of our crops show that whilst the amount of potash, within certain limits, is constant in the ashes of plants, that of soda, especially of chloride of sodium, is liable to great fluctuations, arising, no doubt, from local conditions of the soil.

The fact that soils are capable of absorbing potash from soluble manuring matters, whilst no special care is manifested by them to retain the equally soluble soda salts, appears to me to account, to some extent at least, for the comparative constancy of the amount of potash in the ashes of our crops, as well as for the fluctuation of the amount of soda in the same.

The power of soils to retain potash in large proportions must have the effect of converting the salts of potash in the manure applied to the land into compounds which, though not altogether insoluble in water, are yet sufficiently difficult of solution to permit only a limited and fixed quantity to enter into the vegetable organism in a given period. The case is different with salts of soda; for as soils do not appear to retain them in any high degree, and plants have no selecting power, but absorb by endosmosis whatever is presented to the spongioles of their roots in a state of perfect solution, it is evident that more soda will enter into the plants when grown on a soil naturally abounding in this alkali or heavily dressed with common salt, than when grown upon a soil poorer in soda.

We have here, at the same time, an interesting illustration of the fact that the soil is the great workshop in which food is prepared for plants, and that we can only then hope to attain unto a more perfect knowledge of the nutrition of plants and the best means of administering to their special wants when we shall have studied, in all their details, the remarkable changes which we know, through the investigations of Mr. Thompson and Professor Way, take place in soils when manuring substances are brought into contact with them. The subject is full of practical interest, but also surrounded by great difficulties, which, it appears to me, can only be overcome when the investigation is taken up in a truly scientific spirit, without reference to the direct application which, in due course, no doubt, well-established chemical principles will receive in agriculture. It is the undue anxiety to obtain at once what is popularly called a practical result, the grasping after results which at once may be translated into so

many bushels of corn, which is a great hindrance to the more rapid advancement of agricultural science; and it is to be hoped, for the sake of the true interests of the really practical man, that the voice of those capable of understanding and appreciating purely scientific results will be sufficiently powerful to keep in check the too great anxiety for immediate results.

In the next place, I beg to direct attention to the absorption by the soil of the phosphates contained in drainings. If it is borne in mind that the soil and subsoil with which the liquid was brought into contact contained a large excess of carbonate of lime, it is not more than would be naturally expected, if we should see the soluble phosphates of the original drainings converted by the carbonate of lime into insoluble compounds.

Having already remarked upon the power of this soil to retain ammonia, I beg in conclusion to point out the large quantity of carbonate of lime in the filtered liquid as worthy of notice. This large amount of carbonate of lime is easily explained by the presence of much lime in the soil. Before filtration the liquid contained only about 17½ grains of carbonate of lime, and after filtration as much as nearly 80 grains. Thus whilst potash and ammonia are absorbed by the soil, lime is dissolved and passes into the liquid, which is filtered through the soil. Not only is the quantity of carbonate of lime considerably increased in the filtered drainings, but that of sulphate of lime in a minor degree also.

It is highly satisfactory to me to find the observations of Professor Way with respect to the relative power of soils to retain ammonia, potash, soda, and lime, confirmed in my experiments with a liquid containing a number of fertilising agents required by our crops.

The composition of a liquid like the washings from dung-heaps, when passed through soils, necessarily must be influenced by the composition of the soils employed in the experiment. The results here given and the remarks just made therefore hold good only with soils of a similar composition to the one used in this experiment.

Before describing the next filtration experiments, I may state that I have thought it a matter of some interest to examine what amount of solid organic and inorganic matter a given quantity of pure water would dissolve from the soil, the composition of which has been stated above. Accordingly, one part by weight of subsoil and one part of surface-soil were mixed with four parts by weight of distilled water, and the whole, being occasionally stirred up, left to subside for twenty-four hours, after which time the water was filtered from the soil and carefully analysed.

An imperial gallon of this water was found to contain 84·88 grains of dry residue (dried at 220° F.), consisting of—

Organic matter, and a little water of combination	48·00
Carbonate of lime	26·84
Sulphate of lime	5·73
Phosphate of lime, with a little oxide of iron	·65
Carbonate of magnesia	·50
Chloride of sodium	1·25
Potash	·99
Silica	·92
	84·88

The amount of organic matter in this water is very great; it arises from the great excess of decomposing organic remains in the soil, and imparted to the water a yellow colour and disagreeable smell, not unlike the smell of water in which flax is steeped. It will be further observed that even pure rain-water is capable of rendering soluble a considerable quantity of all those mineral constituents which are found in the ashes of our crops, and therefore are necessary to their growth.

2. *Filtration experiment made with the drainings of a dung-heap composed of fresh-mixed farmyard manure.*—Having ascertained in the previous filtration experiments that a soil containing a good deal of clay and lime is capable of removing from compound manuring substances all the more valuable fertilising constituents, I was anxious to determine to what extent soils deficient in both clay and lime possessed the property of retaining fertilising substances from drainings of dung-heaps. The composition of the liquid used for this experiment is given above; it is the same liquid collected from a fresh dung-heap which in a gallon contained 1357·74 grains of solid matter.

The soil selected for experiment was a light, sandy, red-coloured, very porous soil, containing, as will be seen by the following analysis, only little clay and still less lime, but a good deal of organic matter. It was submitted to a minute and careful mechanical and chemical analysis, and furnished the results embodied in the subjoined tables:—

1. *Mechanical Analysis.*

Moisture	3·45
Organic matter and water of combination	13·94
Coarse white quartz sand	47·00
Fine red sand and a little clay deposited from water on standing 5 minutes	19·82
Coarse clay deposited on standing 10 minutes	2·82
Fine clay deposited from water on standing for 1 hour	6·30
Finest clay kept in suspension in water after standing longer than 1 hour	6·67
	100·00

It appears from these results that nearly half the weight of this soil consists of pure white coarse quartz-sand, which can be readily separated by washing. The deposit which settled from water after five minutes' standing consists chiefly of fine red sand mixed with very little clay. The remainder is clay in a very finely subdivided state, besides humus and some water of combination. The result of the mechanical examination thus shows that the proximate constituents of this soil are present in an advanced state of decomposition. In the following tabular statement the minute chemical composition of the same soil is given :—

2. *Chemical Analysis.*

Moisture	3·45	
* Organic matter and water of combination	13·94	
Carbonate of lime	·31	Containing together ·39 of lime.
Sulphate of lime	·53	
(Containing SO_3 ·31)		
Alumina	14·74	
Oxide of iron	5·87	
Magnesia	·18	
Potash (in a state of silicate)	·25	
Chloride of sodium	·11	
Phosphoric acid, combined with iron and alumina (equal to bone-earth ·131)	·061	
Soluble silica (soluble in dilute potash)	7·42	
Insoluble siliceous matters (almost entirely white sand)	53·32	
	100·181	

* Containing nitrogen .. .. ·192
Equal to ammonia .. .. ·228

5000 grains of this soil were mixed with 5000 grains of liquid from fresh manure heap, and 5000 grains of distilled water. After twenty-four hours the clear liquid was filtered from the soil, and found to be somewhat lighter-coloured than before; but, in comparison with the decolourising properties of the clay-soil used in the experiment with the drainings from rotten dung, its effect upon the dark-coloured organic compounds in the liquid appeared to be weak.

A portion of the filtered liquid was used for the determination of the ammonia contained in it in the form of volatile salts, or, at any rate, in the form of salts which yield ammonia on boiling their watery solution. Another portion was evaporated to dryness, and the amount of nitrogen in the dry residue determined. The rest of the liquid was used for the determination of solid matter and ash.

Leaving unnoticed the details of these various determinations, I shall state at once the composition of the drainings passed through this light sandy soil. I may observe, however, that the

ammonia and nitrogen, as well as the total amount of solid matter and ash in it, were determined twice, and closely agreeing results were obtained. An imperial gallon of liquid from fresh manure passed through red sandy soil contained :—

Ready formed ammonia (chiefly as ulmate and humate of ammonia)	7·13
* Organic matter	301·70
* * Inorganic matters (ash)	245·70
Total amount of solid matter p. gal. of liquid	554·53
Containing nitrogen	12·60
Equal to ammonia	15·30

The ash (245 grs.) consisted of—

Silica	15·08
Phosphates of lime and iron	33·14
Carbonate of lime	21·22
Sulphate of lime	trace
Carbonate of magnesia	2·36
,, potash	85·93
Chloride of potassium	39·49
,, sodium	48·48

It appears distinctly from these results that this soil possessed the power of absorbing manuring matters in a much smaller degree than the stiffer soil used in the preceding experiment. This agrees well with previous observations, in which it was found that soils in which sand greatly preponderates exhibit these useful absorbing properties in the least, and others in which clay preponderates, in the highest degree. The soil used in the last experiment, it is true, contains a fair proportion of alumina, but this alumina exists principally in a free state, or at all events it is so loosely united with silica that it can be easily separated from this combination by dilute acids. The absorbing properties of soils, it thus appears, do not depend so much on the alumina contained in soils in a free state, but, as shown already by Professor Way, rather on peculiar combinations, into the composition of which alumina enters. It is more than probable likewise that the different agricultural clays contain double silicates, to which Professor Way refers the absorbing properties of soils, in very variable proportions, and that consequently the agricultural capabilities of soils, so far as they are dependent upon these important properties, cannot merely be ascertained by determining the proportion of clay which they contain. In short, the mere analysis of soils is not calculated to give us a fair idea of their true characters; nor does it appear to me to afford sufficient indications of what is really wanting in a soil in order to make it yield up heavy crops.

The nature of the changes which these drainings from fresh

farmyard manure underwent in contact with the soil, the analysis of which has just been given, will appear by glancing at the subjoined diagram, in which the composition of these drainings is stated before and after filtration through soil. An imperial gallon of liquid contained—

	Before Filtration through Soil.	After Filtration through Soil.
Ready formed ammonia	7·67	7·13
* Organic matters	358·40	301·70
** Inorganic matters (ash)	312·90	245·70
Total amount of solid matter per gallon ..	678·97	554·53
Containing nitrogen	15·54	12·60
Equal to ammonia	18·86	15·30
Silica	4·75	15·08
Phosphates of lime and iron	36·32	33·14
Carbonate of lime	29·79	21·22
Sulphate of lime	7·14	trace
Carbonate of magnesia	4·98	2·36
,, potash	148·69	85·93
Chloride of potassium	30·32	39·49
,, sodium	50·91	48·48
** Total of ash	312·90	245·70

The amount of ready-formed ammonia retained by this soil, it will be seen, is very trifling indeed; nor is the proportion of nitrogen which is retained in the soil in the form of nitrogenised organic matters very great. We are thus presented here with an instance, showing clearly that there are soils which do not possess the power of absorbing ammonia in any marked degree. In the case of such soils as the one used in this experiment, I think it would be hazardous to apply manure in autumn. I may also mention a curious circumstance in connection with this soil. I am informed that guano and ammoniacal manures do not seem to do much good on this soil, whilst the application of nitre is followed with marked effect.

The most decided change in the composition of this liquid is observable in the proportion of potash which is contained in the filtered liquid; for, as in the case of the former soil, a considerable quantity of this alkali has been absorbed by the sandy soil. On the other hand, there is only a trifling amount less chloride of sodium in the liquid after than before filtration, thus affording another proof that the power of soils to absorb potash is much greater than to retain soda.

It will likewise be observed that, instead of yielding carbonate of lime to the liquid which was brought into contact with the light soil, some carbonate of lime and all the sulphate of lime were actually retained. This soil, it will be remembered, is defi-

cient in lime. Perhaps it may not even contain sufficient to supply the wants of some crops, and seems to be endowed with the property of absorbing lime from manuring matters, affording thereby an interesting instance how special provision is made in soils for the absorption of those constituents which are naturally deficient in them, and which are required in considerable quantities for the healthy and luxuriant growth of our crops.

In the preceding experiment just the opposite took place; for it will be remembered that the drainings, after passing through the calcareous clay soil, contained a great deal more of lime than before filtration. Similar differences will be observed with respect to other constituents originally present in the liquid and retained in the stiff and in the sandy soil in very different proportions. I abstain from noticing any minor changes in the composition of the filtered liquid, nor shall I indulge in any speculations respecting the compounds in the soil which have contributed to these changes and the new combinations in the soil which may have resulted from them. Our present knowledge on the subject is far too imperfect to warrant us to theorise profitably on these matters; I therefore prefer to send forth for the present my analytical results without any further comment, and conclude by expressing the hope that I may be permitted to continue similar inquiries into the physiology of soils, and do not doubt that great and important practical benefits will in due course be derived from increased knowledge of the properties of soils and the changes manuring matters undergo when in contact with them.

Royal Agricultural College, Cirencester,
June, 1857.

VIII.—*Dairy Management.* By THOMAS HORSFALL.

ON resuming my observations for the Society's Journal on the treatment of dairy cows, I cannot properly omit to explain circumstances which appear in some degree to have influenced the results during the present season.

Towards the close of July, 1856, and during the warm weather of August, my cows, whilst in pasture by day and housed during the night, were attacked by that unwelcome visitor the pleuropneumonia, which affected the majority of them, and continued with little intermission to the close of December. Though by treatment which I purpose to describe, nearly all have been restored, yet it is not without more or less damage to the lung—an organ essential to the due performance of every function of

the animal, and exercising especial influence on the respiratory process, and the carbonaceous or fatty products.

In the course of my experience I have ascertained that cattle, whose lungs have been damaged by a previous attack of pleuro or other cause, are deficient in their store of loose fat, in comparison with what their touch, appearance, and the length of time they have been feeding, would lead one to expect. To the same cause I am disposed to attribute the somewhat lessened proportion of butter to milk and to cream during the present, compared with what I have observed during several other seasons from similar treatment.* The proportions have been, from each quart of cream, 20 oz. of butter; and from 16 quarts of milk, 20 oz. of butter. On testing the quality of the milk by a lactometer, I find the proportion of cream less from those which have suffered from pleuro than those which have remained healthy: in one or two instances the difference is marked. In the quantity or yield of milk after recovery, I find little if any difference beyond what might have been expected from the lapse of time during illness.

On the 23rd of March the following results appeared:—

	Quarts.		Oz.
Old milk	340	making of butter	402
Cream churned	20		
Cream used	3	would have made	60
			462

or—

20 oz. of butter from 1 quart of cream.
$20\frac{1}{3}$ oz. of butter from 16 quarts of milk.

This test was made purposely when the temperature of the dairy ranged at 54° to 56° from the time the milk was set up, without the appliance of hot-water, described in a former Journal. The consistency of the cream was such, that on filling a cup, a spoon dipped into it stood erect, the cream being quite sweet.

The most correct way of ascertaining the quantity of thick cream, is to observe the height it reaches in the jar, and then measure the water required to fill the jar to the same height.

In May, with a considerable change of cows, the results were—

$23\frac{1}{8}$ oz. of butter from 1 quart of cream.
$22\frac{6}{15}$ oz. of butter from 16 quarts of milk.

During the continuance of the disease I was prevented instituting comparisons on the effects of different food: my weighings

* The proportion of butter to milk and cream in the winter of 1854–55 was shown in my last paper (Journal, vol. xvii. p. 268) to have been—

25 oz. of butter from 16 quarts of milk.
25 oz. of butter from 1 quart of cream.

were likewise discontinued, with the exception of one made on the 8th of October, when the cows were confined wholly to their stalls.

Comparison of different Methods of Feeding Dairy Cows.

Being desirous of comparing the result of my method of feeding dairy cows with the system usually practised in this locality, it occurred to me that as my cows had been accustomed to savoury steamed food, a change to ordinary food would be attended with less favourable results than if they had been previously treated in the common mode; and that under these circumstances it would be better to institute comparisons with two near neighbours, Mr. Smith and Mr. Pawson, whose practice and results I had the opportunity of inspecting.

Mr. Smith's cow was of rather small frame, but noted for her usefulness as a good milker. At the time of calving her third calf, about the 12th of November, she was in good condition, and gave soon after 17 quarts of milk per day. Her owner states that in the first three weeks (up to the time this comparison was begun) her condition sensibly diminished—a result which I apprehend will be invariable with cows giving this quantity of milk when fed on meadow hay only, with which Mr. Smith's cow was supplied *ad libitum*, and of which she consumed 28 lbs. per day. Mr. Pawson's was a nice heifer, three years old at the time of calving her first calf, October 6th, in more than ordinary condition, and gave about 16 quarts per day. Her owner states, that on the 1st of January her condition was much diminished; this is corroborated by Mr. Myers, a dealer in the village, who tells me, that previous to her calving, he was desirous of purchasing her, and would have given from 17*l.* 10*s.* to 18*l.*, and describes her as being at that time full of beef. Her weight on the 1st of January, 7 cwts. 2 qrs., bespeaks her condition as much lowered.

During the month of October and till late in November, she was turned out in the daytime to graze on aftermath and housed during the night, where she was supplied with turnips. From the close of November till the first week in February her food consisted of—

Meadow-hay of inferior quality	18	lbs. per day.
Swede turnips	45	,,
Ground oats	9	,,

After this the ground-oats were discontinued and meadow-hay of good quality was given *ad libitum*, with 45 lbs. of turnips.

For comparison I selected a cow of my own, which calved about the 8th of October, and gave soon after 18 quarts of milk per day; she was also of small size. At the time of calving

her condition was somewhat higher than that of Mr. Smith's. When the experiment was begun, on the 1st of January, no perceivable difference was found in the yield of milk of Mr. Smith's cow and my own, each giving 15½ quarts per day.

The following Table gives the dates of calving of the three cows, together with their weights and yield of milk at the commencement and termination of the experiment:—

When Calved.	Yield at Calving.	January 1.				March 5.			
		Weight.			Yield.	Weight.			Yield.
	Quarts.	Cwt.	qrs.	lbs.	Quarts.	Cwt.	qrs.	lbs.	Quarts.
Mr. Smith's—November 12 ..	17	8	3	0	15½	8	0	0	9½
Mr. Pawson's—October 6	16	7	2	0	12	7	1	0	6¼
My own—October 8	18	9	3	0	15½	10	1	0	12½

Mr. Smith's cow lost in weight in nine weeks 84 lbs., being 9⅓lbs. per week, with an average yield of 12½ quarts per day. Mr. Pawson's lost 28 lbs.: this loss, together with the diminished yield of milk, occurred almost wholly after the oats had been withdrawn. Her weight on the 6th of February being still 7 cwt. 2 qrs., and her yield of milk, 11 quarts per day.

My cow has gained, in the nine weeks, 56 lbs., being 6¼ lbs. per week, with an average yield of 14 quarts, the diminution being regular. January 1st, 15½; Feb. 4th, 14; March 4th, 12½; making an average yield of 14 quarts per day. The whole loss and gain of weight will be in flesh and fat, the cows having kept up their consumption of food and their bulk.

The weekly account of profit and loss will stand as follows:—

	s.	d.
Mr. Smith's cow, average yield for 9 weeks, 12½ quarts per day, at 2*d*. per quart	14	7
Deduct loss in flesh 9⅓ lbs., at 6*d*.	4	8
	9	11
Cost of 14 stones hay, at 6*d*. per stone	7	0
Profit	2	11

	s.	d.
Mr. Pawson's cow, average during the first 5 weeks, 11½ quarts per day, at 2*d*. per quart	13	5
Cost of 9 stones inferior hay (at 4*d*. per stone), per week .. .. 3*s*. 0*d*. Cost of 63 lbs. ground oats, 4*s*. 8*d*.; turnips, 1*s*. 6*d*. 6*s*. 2*d*.	9	2
Profit	4	3

	s.	d.
My cow, average yield for 9 weeks, 14 quarts per day, at 2*d.* per quart	16	4
Gain of flesh, $6\frac{1}{4}$ lbs. per week, at 6*d.*	3	$1\frac{1}{2}$
	19	$5\frac{1}{2}$

Cost of food:—

	s.	d.	s.	d.
Hay, 63 lbs., at 6*d.* per stone; straw and shells of oats, 1*s.* 3*d.*; mangel, 1*s.*..	4	$6\frac{1}{2}$	8	7
Rape-cake, 35 lbs.; bran, $10\frac{1}{2}$ lbs.; malt-combs, $10\frac{1}{2}$ lbs.; bean-meal, $10\frac{1}{2}$ lbs.	4	$0\frac{1}{2}$		
Profit			10	$10\frac{1}{2}$

The richer quality of the manure will probably compensate for the extra labour, cooking, and attention bestowed upon my cow.

With a view of extending the comparison I give particulars of the whole of my cows, the weights of which were registered on the 8th of October, and which were still on hand, free from calf, and in a state admitting of comparison. These were bought at a neighbouring market in but moderate condition: indeed with my mode of feeding I do not attach the same importance to high condition as a town-side farmer would. A cow in full condition attains her maximum yield in a week or so after calving, whilst those in lower condition continue, by my treatment, to increase their quantity up to about a month after calving.

The dates of calving are not precisely those on which the cows calved, but on which they were purchased as new calven cows. The prices named are those paid for the cows without their calves, except in one instance, the cow No. 1 being bought a few days before calving. They are what may be termed young cows, having had two or three calves each. The prices will disclose to those conversant with the subject, that the animals were not in high condition nor of high breed.

No.	When Calved.	Price.		Greatest Yield per Day.	Oct. 8. Weight.			Feb. 4. Weight.			Feb. 4. Yield per Day.	Mar. 4. Weight.			Mar. 4. Yield per Day.	Computed Average per Day during		Gain. Oct. 8 to Feb. 4.	Gai in Weig per Wee
		£.	s.	Quarts.	Cwt.	qrs.	lbs.	Cwt.	qrs.	lbs.	Qts.	Cwt.	qrs.	lbs.	Quarts.	Wks.	Qts.	lbs.	lbs.
1	July 28	14	9	12	9	2	0	10	0	0	8	10	1	0	8	29 =	10	84	4
2	Aug. 25	15	14	18	10	0	0	11	1	0	14	11	1	0	14	27 =	16	140	6[illegible]
4	July 28	15	9	18	8	2	0	10	1	0	15	10	0	0	15	31 =	15	168	8
6	Sept. 8	16	15	16	10	2	0	10	2	0	14	10	3	0	14	25 =	15	28	1[illegible]
7	Sept. 8	17	9	16	10	2	0	11	0	0	10	11	0	0	10	25 =	13	56	2[illegible]
11	Aug. 25	15	9	16	9	1	0	9	2	0	11	9	2	0	11	27 =	$13\frac{1}{2}$	28	1[illegible]
	Average . .			16	. .			. .			12	. .			12	$27\frac{1}{3}$ =	14		

My cows, during the period under consideration, were treated as follows:—During August and September they were on open

pasture by day and housed by night; evening and morning they were supplied with mown grass, and two feeds of steamed mixture. Towards the close of September green rape was substituted for the mown grass, with the same allowance of steamed mixture; from the 8th of October, when they were wholly housed, they were supplied with steamed food *ad libitum* three times per day. After each meal 10 to 12 lbs. of green rape-plant were given, and 9 lbs. hay per day till November; from that time steamed food with cabbages or kohl rabi till the early part of February, when mangel wurzel was substituted. It will be observed that I give hay and roots in limited quantities, and the steamed food *ad libitum;* I prefer this to apportioning the cake and other concentrated food in equal quantities to each; as this steamed mixture contains more of the elements essential to milk, and each cow is thus at liberty to satisfy her requirements with it. Nos. 2 and 4, which have given the greatest quantity of milk, have eaten more than their share; whilst No. 1, which has given the least milk, has scarcely eaten more than half the quantity of steamed mixture consumed by 2 or 4. The yield of milk and the live weights on the 4th of February and the 4th of March scarcely vary. During February 34 lbs. of mangel were substituted for kohl rabi; with this change the cows became more relaxed. My experience in weighing, extending over several years, has shown me that when animals, from change of food, become more relaxed or more costive, their weighings in the former state denote less, whilst in the latter they denote more than their actual gain in condition. I have known instances in which a month's weighing, accompanied by some relaxation, has shown no gain, whilst in the following month, with restored consistency, the gain has doubled.

The results I have described are wholly over periods commencing from the time of calving, and during the first stages of milk, the longest extending over thirty-one weeks, when the production of milk is at the largest.

No. 4 suffered from pleuro in September, from which time her yield of milk fell off to less than two quarts per day.

Nos. 6 and 7 suffered also, and No. 11 considerably, after their weighing, Oct. 8th: each of them regained their yield of milk after recovery. It will be clear that their weights would have been greater had they continued in health throughout. In stating their produce of milk and food, I treat them as if they had remained in health.

I now proceed to examine the materials of food, their composition, and the probable changes they undergo in the animal economy:—

QUANTITY and DESCRIPTION of FOOD supplied to 6 Cows during $27\frac{1}{3}$ weeks,

	Per Day.	Total Weight of Food given.	Cost per ton.	Total Cost.	Weight of Food when dried.
	lbs.	lbs.	£. s. d.	£. s. d.	lbs.
Meadow Hay ..	56	10,715	4 0 0	19 2 9	9,420
Rape-cake	30	5,740	6 10 0	16 12 0	5,456
Malt-combs	9	1,722	5 9 0	4 3 0	1,660
Bran	9	1,722	6 10 0	5 0 0	1,500
Beans	9	1,722	9 6 8	7 3 6	1,500
Green food	204	39,032	0 10 0	8 14 6	5,740
Oat-straw *	50	9,566	1 15 0	7 9 0	8,407
Bean-straw	12	2,296	1 15 0	7 16 0	1,964
Total ..	379	72,515		70 0 9	35,647

Analysis of Milk by HAIDLEN.

Water	873·
Butter	30·
Casein	48·2
Milk sugar ..	43·9
Phosphate of Lime	2·31
Magnesia	·42
Iron	·07
Chloride of Potassium	1·44
Sodium and Soda	·66
	1000·00

Production of Milk by 6 cows, average 14 quarts per day each for $27\frac{1}{3}$ weeks = 16,072 quarts, which at 41 ozs. per quart = 41,184 lbs.

	lbs.
When dry or free from moisture	5230
Butter in 16,072 quarts at 30 per 1000 =	1235
Casein ,, ,, 48·2 ,, =	1977
Sugar of Milk .. .. =	1804
Minerals {Phosphate of lime .. 99, Other .. .. 115} =	214
	5230

Gain of weight 500 lbs., of which I compute .. .. 300 lbs. as fat.
200 lbs. as flesh.
500

Nitrogen	316 lbs.
Phosphate of lime	99
Phosphoric acid	= 45·50

Cost of Food per Cow per week .. .. 8*s.* $6\frac{1}{2}$*d.*
When the yield of milk is less, the cost of food is reduced to 7*s.* 8*d.* per week.

	s.	d.
Gross return in Milk	16	4
,, Weight	1	6
,, Manure	2	8
	20	6

* The cost of shells of oats, of which I use an equal quantity, is 16*s.* per ton.

and its Composition in proximate Elements and Minerals.

Albumen.	Starch.	Oil.	Fibre.	Minerals.
lbs. 990	lbs. 4,257	lbs. 287	lbs. 2,933	lbs. 953
1803	2,177	611	494	171
411	791	51	320	88
246	800	96	258	100
464	774	34	176	53
862	3,074	115	1,148	541
287	3,066	100	4,526	428
376	725	51	594	217
5,439 = Nitrogen 888 lbs.	15,664	1,345	10,449	2,551

Analysis of Excrement by Professor WAY.

	Per cent.
Moisture	84·85
Phosphoric acid ..	·39
Potash	·58
Soda	·22
Other substances ..	13·96
	100·

Nitrogen ·41 =
Ammonia ·49

Manure 88 lbs. per cow per day.
For 6 cows per day 528 lbs. = 3696 lbs. per week
,, for $27\frac{1}{3}$ weeks 101,028 lbs., containing
of Nitrogen .. .. .. 414 lbs.
Phosphoric acid 393
Potash 585

Nitrogen incorporated in food		888 lbs.
Casein	316·	
Fibrin	7·35	
Manure	414·	
Balance consumed in perspiration	150·65	
	888·00 lbs.	

The materials of food are shown to have cost .. .. £70. 0s. 9d.

	£.	s.	d.	£.	s.	d.
Gross value 16,072 quarts of milk, at 2d. per quart				133	18	8
Gain of weight 500 lbs., at 6d. per lb.				12	10	0
Nitrogen in manure 414 lbs. = Ammonia 494 lbs. at 6d. ..	12	7	0			
Phosphoric acid .. 393 lbs. at $1\frac{1}{2}d.$ per lb.	2	9	1			
Potash .. .. .. 585 ,, at 3d. ,, ...	7	6	3			
				22	2	4
				£168	11	0

	s.	d.
Manure per cow per day 88 lbs., per week 616 lbs.		
Containing ammonia 3 lbs.	1	6
Phosphoric acid 2·40 lbs.	0	$3\frac{1}{2}$
Potash 3·57 lbs.	0	$10\frac{1}{2}$
Value of a cow's excrement, per week	2	8

The analyses of the chief ingredients of my own produce, or such extra materials as I usually purchase, have been made by Professor Way; for other materials I have had recourse to a very useful compilation by Mr. Hemming (vol. xiii., p. 449, of the Society's Journal), and to Morton's 'Cyclopædia of Agriculture.' The analysis of straw is that of oat-straw; that of green food is derived from the analysis of rape-plant, cabbages, and kohl rabi. During February and March I have been using wheat and barley-straw with mangel, and as these materials contain less oil, I give in the steamed food three ounces of linseed oil per day to each animal. For the composition of milk I adopt that by Haidlen, whose method of analysis is reputed to be the most accurate, the proportion of butter in my milk being this season very similar to that given by him.

It will be observed that this is the gross return for 27⅓ weeks from the time of calving, from which will have to be deducted expense of attendance, &c.

	£.	s.	d.	£.	s.	d.
The materials used as food are found to have cost				70	0	9
The value of these materials as manure consists of 888 lbs. nitrogen = 1061 lbs. ammonia at 6*d*.				26	10	6
Phosphoric acid and potash				9	15	4
Value of food if employed as manure				£36	5	10
The 16,072 quarts of milk, at 2*d*. per quart for new milk, at which price it enters largely into consumption as food for man, amount to				£133	18	8
The nitrogen in the milk 316 lbs. = ammonia 378 lbs., at 6*d*. per lb.	9	9	0			
Phosphoric acid in ditto 45½ lbs. at 1½*d*. per lb.	0	5	8			
				£9	14	8

From these statements it will be seen that materials used as *food for cattle* represent double the value they would do if used for manure, whilst that portion converted into *food fitted for the use of man* represents a value thirteen to fourteen times greater than it would as manure.

It then appears clear that it is for the feeder's profit to use his produce as much as possible as food for cattle, with the view to convert it with the utmost economy into food for man, and *thus increase rather than enrich his manure-heap.*

The calculation of casein in milk is based upon the supposition that my milk is equal in its proportion of that element to

that analysed by Haidlen. Several analyses by other chemists show a less percentage, 4 to 4·50. As my cows are adequately supplied with albuminous matter, I have a right to presume on their milk being rich in casein.

The loss of nitrogen by perspiration, 150·65 lbs., is nearly 17 per cent. Boussingault found a loss of 13·50 of nitrogen in a cow giving milk.

	£.	s.	d.
The abstraction of nitrogen in the milk is computed at 316 lbs., value	9	9	0
The abstraction of phosphoric acid in the milk is computed as $48\frac{1}{2}$ lbs.	0	5	8

Either the rape-cake or bran alone suffices for the restoration of the phosphoric acid.

The amount of phosphoric acid in the manure is 393 lbs., being about 16 per cent. of the whole ash or mineral matter. The ash of meadow-hay contains about 14 per cent.; that of rape-cake, 30 per cent.; bran, 50 per cent.; malt combs, 25 per cent.; turnips, &c., 10 per cent. of phosphoric acid.

The amount of potash in the excrement is 616 lbs., being about 25 per cent. of the whole ash or mineral matter. The ash of meadow-hay contains about 20 per cent.; rape-cake, 21 per cent.; malt-combs, 37 per cent.; turnips (various), 44 per cent.; from which it may be inferred that the sample of excrement sent to Professor Way for analysis did not contain more than a fair proportion of these ingredients.

To ascertain the quantity of excrement, the contents of the tanks into which the cows had dropped their solid and liquid excrement during five weeks were weighed, and found to be 500 cwt. 2 qrs. 0 lbs. from 18 cows, being 88 lbs. per cow per day. The sample for analysis was taken from that which the cows had deposited within the preceding 24 hours. This was collected in the mud-cart, well blended, and sent off quite fresh.

It is sufficiently proved by the experience of this district, that 20 lbs. of meadow-hay suffice for the maintenance of a cow of fair size in store condition: a like result is stated to be obtained from 120 lbs. of turnips per day. The six cows will have then required during the $27\frac{1}{3}$ weeks for their maintenance only—

Per Day.	Weeks.	Total Weight.		Albuminous Matter.	Oil.	Starch, &c.
lbs.		lbs.				
120 of Hay, or for ..	$27\frac{1}{3}$	22,960	containing of	2127	616	9130
720 of Turnips, or for	$27\frac{1}{3}$	137,760	"	2295	306	9100

They will further have required adequate food—

	Albuminous Matter, Fibrin, and Casein.	Oil and Butter.	Starch and Sugar of Milk.
For the production of	2,116	1,235	1,894
Add for Maintenance by Turnips	2,295	306	9,100
	4,411	1,541	10,994
The food supplied is computed to have contained	5,459	1,345	15,664

I omit the minerals, which are observed to be in excess of the requirements.

For the maintenance of a fair sized cow for one day in a normal state, the following elements seem adequate :—

	Albumen.	Oil.	Starch, &c.	Lime.	Mineral Ingredients. Phosphoric Acid.
In 20 lbs. of Hay ..	1·85	·536	7·95	·90	1·11
120 „ Turnips	1·98	·26	7·82	·97	1·9

When cows are in milk, there occurs a much greater activity of the functions; they eat and drink more, evacuate more excrement, and, in all probability, spend considerably more food in respiration. Whilst the 17·60 lbs. per day dry matter in 20 lbs. of hay are found adequate for the maintenance of a cow in a store state, the six cows in milk have eaten on the average 21·37 lbs. solid matter per day during the 27⅓ weeks. When I have fattened cattle together with a number of milk cows of similar size, which gave on an average 8 quarts of milk per day, the whole being fed with moist steamed food, and receiving the same allowance of green food, I have found the fattening cattle refuse water, whilst the milk cows on the average drank upwards of 40 lbs. per day of water given separately: the 8 quarts of milk contain only about 17·58 lbs. of water; still in several analyses of excrement I have noticed little difference in the percentage of moisture in that from the fattening animals as compared with that from cows giving milk.

These facts would seem to show that upwards of 20 lbs. more water were given off from the lungs and pores of the skin of a milking than of a fattening animal.

The excrement of the six milk cows, 88 lbs. per day on the average, is found to contain of nitrogen ·36, equal to that in 2·25 lbs. of albumen; whilst 1·85 of albumen in the 20 lbs. of hay is found adequate for maintenance.

On comparing the supply of the food to the six milk cows with their requirements and production, there seems an excess in the albuminous matter, a deficiency in the oil for the fat and butter, an excess in the starch, &c. Taking, however, the increased activity of the animal functions and consequent consumption of food by the milk cow, I am not encouraged to lower my standard of food. That it has sufficed, is abundantly proved, as each of the six cows under observation has gained in condition during 27½ weeks.

My observations on nutrition tend to the conclusion, that if you supply animals with starch, sugar, &c., to satisfy their requirements for respiration, you enable them to convert the oil of their food into butter or fat to such extent as their particular organism is fitted for effecting it.

In the treatment of the six cows it will be seen that the oil in the food is inadequate for the supply of the butter and of the fat, some portion of which will have been derived from the starch, sugar, &c. Of the efficacy and adaptation of these for the production of fat, I propose to explain my views by drawing a comparison as to the production of food adapted for the use of man in the form of beef and of milk, on which I find in recent and deservedly popular works what appear vague and extravagant statements.*

On entering upon this comparison it is necessary that I should explain my conclusions on a subject to which, as far as my reading and information extend, little inquiry or attention has been given, viz. the whole gain of weight and the proportions of useful material and offal made by cattle whilst fattening.

Weight of Meat gained by Fattening Cattle.—Not being a breeder of horned stock, I purchase my milk cows and cattle for fattening in the markets of the neighbourhood. I prefer, for fattening, full-grown cows, which have had one, or, at the most, two calves, at from three to five years old. The breeds of this district are mixed short-horns, the bulls used having a large admixture of short-horn blood. The live weight of the cattle I buy for fattening is from 7 cwt. to 9 cwt. each. Their capability of carrying additional weight may be taken at 3 cwt.; so that when prime fat they will weigh from 10 to 12 cwt. Their dead or carcase weight, if killed in a lean state, will be less than one-half their live weight, varying probably from 43 to 46 per

* Professor Johnston, in his 'Agricultural Chemistry' (p. 406), quotes (though with hesitation) Sir John Sinclair and M. Riedesel, the former of whom states that the same weight of herbage which will produce less than 30 lbs. of dry human food in the form of beef will yield 500 lbs. in the form of milk; and the latter says that the same quantity of hay will produce either 100 lbs. of beef or 1000 lbs. of milk.

cent. In Morton's 'Cyclopædia,' article on Meat, the comparison of carcase and live weight is stated as 50 per cent. when half fat, of cattle of like quality. This tends to confirm my estimate of the proportion of live to dead weight of lean stock.

I will consider for example a lean animal weighing 8 cwt., and capable of weighing, when prime fat, 11 cwt. live weight; when fairly started, and with proper feeding, I should look for an average gain of 14 lbs. per week live weight. At this rate it would require 24 weeks to bring it to a state of prime fatness, and the comparison of live and dead weight when lean and fat would stand as follows:—

Lean	Live weight = 8 cwt.	
	Dead weight, at 45 per cent. = ...	$28\frac{3}{4}$ stone
Fat	Live weight = 11 cwt.	
	Dead weight, at 60 per cent. = ...	$52\frac{3}{4}$ „
	Gain in dead weight in 24 weeks ..	24 „

or 14 lbs. per week, being precisely the average gain in live weight.

In the course of feeding there is a gradual increase of interior fat of two descriptions—fat in the loins, which is weighed with the carcase, and loose fat or tallow which counts as offal. Even though this loose fat counts as offal, it is well known that cattle well stored with this weigh heavier in proportion when killed than those with less, and which are in lower condition. A consideration of this has led me to infer, that with the increase of this interior fat there occurs a displacement of material in process of digestion; and on inquiry of butchers of experience, I learn that one characteristic of a beast which kills well, is to have a little stomach. On looking over the items of offal of full-grown animals, they appear capable of little variation in the same animal, except the loose fat and the stomach, in each of which there occurs a difference of 100 lbs. or upwards.

The writer of the article on Meat, in Morton's 'Cyclopædia,' attributes this greater carcase weight of fatted beasts to greater solidity: to hollows being filled up and protuberances being formed. It seems, however, clear that this would equally affect the live weight, and does not therefore satisfactorily explain the matter just mentioned.

If these views be correct, it appears that besides a gain of carcase weight, which is shown to be 14 lbs. per week, on animals which gain this in live weight, there is likewise a gain of loose fat, which, from observation, I am led to estimate at 3 lbs. per week, or 72 lbs. for the 24 weeks. An animal in a lean or store state will contain about 30 to 35 lbs. of loose fat. After 24 weeks' feeding, I should expect 104 to 112 lbs. of loose fat.

The gain in carcase weight I estimate as	14 lbs.	per week.
„ in loose fat	3	„
Whole gain per week	17 lbs.	

I may here remark, that if the feeder expect a weekly return equal to the price of the whole of the gain in live weight, he is likely to be mistaken. Though favourably situated for the purchase of stock, I am seldom able to purchase lean stock, which, if killed at the time of purchase, would not, in accordance with the computation stated, cost more per lb. than the price of fat stock at the same time. The difference in my case will be from 30*s.* to 40*s.* per beast, which will be a deduction of 1*s.* 6*d.* to 2*s.* per week from the earnings reckoned on the gain of live weight.

In addition to the interior fat, tallow, and suet, there is an increase in the fat of the beef, and of that mixed with the flesh. That this increases in a greater proportion than the flesh seems clear, as fat beef is a term used to signify beef having a greater proportion of fat to flesh. I am therefore disposed to estimate the gain per week as composed of

	lbs.
Loose fat or tallow, per week	3
Fat with beef and suet in the loin	8
Fibrine or flesh	6
Total gain per week	17

As flesh contains 77 per cent. moisture, the weekly gain for each in dry material will be—

	lbs.
Fat	11
Dry fibrine	1·38
	12·38

Extending this over $27\frac{1}{3}$ weeks, six cows would have gained in fattening—

	lbs.
Fat	1802
Dry flesh	226
	2028

The gain by milk cows has been, during $27\frac{1}{3}$ weeks—

	lbs.	lbs.
In butter	1235	
„ sugar	1894	
„ fat	300	
Gain in respiratory elements ..		3429
In casein	2100	
„ fibrine	46	
		2146
Salts or mineral matters		240
		5815

The whole computed gain in solid food by milk-cows is nearly three-fold, whilst that of casein is nearly *ten-fold* the amount of dry fibrine gained in fattening.

There is besides a consideration affecting the two processes: by that of milking there is a continuous drain on the albumen of the food by the production of casein, whilst by fattening the tendency is to repletion of the fibrine. When this has acquired its full development, the requirements of albumen in the food will be limited to what is necessary for the maintenance of the flesh.

Excrements of Fattening Cattle.—With the object of informing myself, and for the better understanding of my practice, I had recourse to the following experiments during the years 1852 and 1853. Eight fair-sized fattening cattle were supplied daily with

18 lbs.	oat straw, shells of oats, and bean-straw.
4 ,,	rape-cake and bean-meal.
22	

with which they drank about 70 lbs. of water each. The yield from this in solid and liquid excrement was found to be, for every 100 lbs. fodder and water, 72½ lbs. excrement, being about 10 tons per animal during the year. I give the analysis of the excrement by Professor Way :—

	lbs.
Moisture	81·77
Organic matter, sand, and silica	15·51
Phosphate of lime	·65
Other substances	2·7
	100·00

Nitrogen ·45 = ammonia ·54 per cent.

The next cattle under experiment were eight heifers which had scarcely attained their full growth. After allowing a short time for change of food, they gained evenly and steadily throughout 16 weeks, during which their weight increased from 7¾ to 9¾ cwt. each (on the average), being 14 lbs. per week. They were supplied with turnips or other green food at the rate of 60 lbs. per day—with chopped straw, together with 4 lbs. rape-cake and 2 lbs. of bean-meal each per day for ten weeks; from this time, during six weeks, to the conclusion of the experiment 3 lbs. each per day of rape-cake in addition, making 7 lbs. rape-cake and 2 lbs. bean-meal per day for each. I supply the amount and description of food for 21 days, during which the 7 lbs. of rape and 2 lbs. of bean-meal per day to each were given:—

	Weight of Food.	Composition of Food.		
		Water.	Organic.	Mineral.
	lbs.			
Rape cake	1176·	99·84	1042·	34·10
Bean meal	336·	48·50	278·75	8·75
Shells of oats	1260·	dried	1162·	98·
Swede Turnips	10080·	8907·	1100·	73·
Hay of inferior quality	1176·	165·25	949·50	61·25
Water	846·	846·	..	..
	14874·	10066·59	4532·25	275·10
Excrement	9600·	8152·	1163·50	284·25
Deficiency *	5274·	1914·59	3368·75	plus 9·15

Nitrogen in Rape cake	59·04
,, Beans	16·75
,, Shells of oats	8·
,, Turnips	28·
,, Hay..	12·
	123·79
	lbs.
In 9600 lbs. excrement .. .. .. Nitrogen	75·84
In 169 lbs. flesh dry fibrine, 38·87 = Nitrogen	6.24
	82· 8
Nitrogen spent in perspiration ..	41·71
	123·79

The gain in weight during these 21 days was 338 lbs., or 14 lbs. each per week. The proportion of flesh is assumed to be 169 lbs., or one-half the gain of weight, and seems ample, though the cattle were still growing.

The analysis of the excrement by Professor Way gives, of

Moisture	84·92
Organic matter, with salts of ammonia ..	12·12
Sand	·93
Phosphate of lime	·72
Alkalies, sulphates, &c.	1·31
	100·00

Nitrogen ·79 = ammonia ·96.

Barral states the proportion of the nitrogen which escapes by perspiration as one-third or one-fourth of that in the food. Boussingault found that in a cow giving milk there was an escape of 13·50 per cent. of the nitrogen, whilst a turtle dove parts with 35·04

* Chiefly consumed in respiration and perspiration, the remainder being converted into flesh, fat, &c.

per cent. of this element. This loss of nitrogen seems hitherto to have been little noticed by practical feeders. It seems possible that this loss may be increased by too liberal a supply of albuminous matter in the food.

The next experiment was on eight cattle, and commenced March, 1855; the first six weeks after they were tied up, their food consisted of chopped straw, shells of oats, and bean-straw, in about equal proportions; 4 lbs. of rape-cake, 1 lb. bean-meal, ½ lb. linseed, and ½ lb. wheat ground together, and 30 lbs. swedes per day. The straw, &c., were cooked by steaming. On this food two of the heifers had gained 9 lbs. each in the month's weighing, the others 16 lbs. and 18 lbs. each per week; the average being somewhat more than 14 lbs. per week. A sample of the excrement was sent on the 26th of March to Professor Way for analysis, which gives—

	lbs.
Moisture	83·81
Organic matter	13·44
Sand, &c.	·93
Phosphate of lime	·64
Common salt	·18
Sulphate of soda and potash	·95
	99·95

Nitrogen ·51 = ammonia ·62.

The yield of excrement is at the rate of about 9½ tons per year; value, 8*s.* 6*d.* per ton; or 1*s.* 7*d.* per week for each.

My store of turnips being exhausted with March, an additional proportion of bean-straw, with the above-mentioned allowance of rape-cake, bean-meal, linseed, and wheat ground together, was supplied till the 24th of May, when a portion of meadow-grass was mixed with the straw, and by degrees the straw was discontinued; when mown grass, together with the same allowance of extra food, was given till the close of June, when the lot were of prime quality, and sold for the top market price. Up to the close of May their gain averaged over 14 lbs. per week; during June they gained something less than 14 lbs. per week. On the 29th of June a sample of excrement was sent to Professor Way, who reported its contents :—

	lbs.
Moisture	84·90
Organic matter	11·94
Sand	·86
Phosphate of lime	1·33
Common salt	·24
Sulphate of soda and potash	·76
	100·00

Nitrogen ·94, equal to 1·14 ammonia.

The yield of excrement was at the rate of 9½ tons per year, and its value in ammonia and phosphate of lime may be computed at 15*s.* per ton, being at the rate of 2*s.* 10½*d.* per week for each, to which the sulphate of potash will be an appreciable addition.

It will be observed that the bulk of food supplied when this sample of excrement was sent for analysis was meadow-grass, at the time of year when it is rich in nitrogen, and this would materially affect the proportion of nitrogen in the excrement. It would have afforded a more correct test of my views as to the disposition of animals to assimilate more of nitrogen in the early, and of fat in the later, stages of feeding if the same food had been continued throughout. Still when I find in the advanced stage of feeding the excrement doubly rich in nitrogen, with scarcely an equal gain in weight, this tends to confirm such an inference.

It seems probable that the supply of extra food, during June, as far as regards the nitrogenous principle, was superfluous. The cost of this extra food is 3*s.* 2½*d.* per week; the increase in the value of the excrement will be about 1*s.* 7*d.*, as the excrement without the extra food would probably have been worth 1*s.* 6*d.* per week.

On each occasion the sample of excrement sent for analysis was taken from the quantity of solid and liquid evacuated during the preceding 24 hours, well blended and sent off quite fresh.

These experiments were concluded in June, 1855, since when my treatment has undergone some modifications.

Efficacy of Sugar and Starch in the production of Fat.—I now call attention to a subject which has been long a matter of controversy amongst the teachers of agricultural chemistry, and which may be considered as barely settled—the efficacy of sugar and starch in the production of fat. In the Highland Agricultural Society's Journal I find well-authenticated and reliable statements by Mr. Hope of Fenton Barns and others, to the effect that cattle supplied with turnips—170 lbs. to 180 lbs. per day, with 5 lbs. of straw per day—had gained throughout a course of feeding 14 lbs. per week—a gain I have scarcely found exceeded, taking the average of a lot for a lengthened course. From various analyses of these materials, and selecting those of good average quality, I deduce the following proportions in lbs. for 24 weeks :—

	Per Day.		In 24 Weeks.			
				Composition.		
	Natural State.	Dry.	Whole Weight, Dry.	Albuminous Matter.	Oil.	Starch, &c.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Turnips	175	19·25	3234	485·10	64·68	1940
Straw	5	4·40	1056	31·50	7·	420
	180	23–65	4290	516·60	71·68	2360
As requisite for maintenance only, without gain	120	13·20	2217	332·55	..	1440.80
The remainder for increase				184· 5	71·68	919·20

	lbs.
I assume * the oil or fat of 120 lbs. of turnips per day (or for 24 weeks, 44·34 lbs.) to be required for maintenance, and compute it as equal to starch, in proportion of 2 lbs. of oil to 5 lbs. of starch and sugar, or 44·34 lbs. .. .. =	110·88
Starch and sugar in 120 lbs. of turnips per day for 24 weeks	1330·12
	1441·

It will be observed that the 184·5 of albuminous matter is greatly in excess of what is required for assimilation or increase of flesh. This supply of albumen represents 7·66 lbs. of dry fibrine per week, which with the usual proportion of moisture, 77 per cent., is equal to a gain per week of 33·30 lbs. of flesh, whilst my computation of gain per week in flesh is only 6 lbs. It then follows that the manure or excrement from cattle whilst fattening on turnips only will be richer in nitrogen than when supplied only with the quantity required for their maintenance.

Professor Way, in the Royal Agricultural Society's Journal, vol. iv. p. 181, gives the analyses of twenty-two kinds of grasses in the dry state, comprising most of those which prevail on our feeding pastures, from which he derives an average of—

Albuminous Matter.	Oil and Fat.	Starch, Sugar, &c.
10·98	3·08	45·57

These analyses were made on grasses chiefly when in flower. Every grazier of experience will agree in saying that grass in a younger state will fatten more satisfactorily. This younger grass will differ chiefly in its less proportion of woody fibre, which, in the grasses analysed by Professor Way, averaged 35 per cent. A portion of this will in the younger grasses be represented by sugar, starch, &c.; their percentage of moisture is also greater.

* *Vide* Lehmann, Cavendish Society's Ed., vol. iii.

There are no grounds whatever for assigning to the younger grasses a greater percentage of albuminous matter or flesh-forming principle.

The proportion of woody fibre is doubtless considerably influenced by the quickness of growth also, to which I have called attention in a former Number of this Journal, the plants of quicker growth having a less proportion of woody fibre, and more of starch, sugar, &c. And to this I am disposed in a great degree to attribute the fattening properties of fertile pastures in comparison with those on poorer soils—in corroboration of which I may state that I have, by dressing with bones and other manures, inducing quickness of growth, converted old store pastures on clay, on which cattle would graze for a season with but little increase, into fattening pastures. Mr. Garnett also, of Wharfeside, near Otley, has found a like effect from top-dressing pasture with guano, at the rate of 1 cwt., and 1 cwt. common salt per acre for three seasons in succession; this pasture on alluvial loam carries in consequence 50 per cent. more cattle, and fattens them much more quickly than before. Mr. Garnett attributes this not solely to the increased produce, but also to the improved quality of the grass, which in my estimation will in a great measure be owing to the greater percentage of sugar, starch, &c.

Assuming that cattle whilst on pasture require an equal quantity of solid matter as when supplied with 175 lbs. turnips and 5 lbs. of straw per day, they would consume 23·65 lbs., or 4290 lbs. in 24 weeks, and taking into account that pastures have some admixture of perennial clovers, which are richer in albuminous matter than the natural grasses, we may compute the percentage of albumen as increased to 12 per cent. Thus the 4290 lbs. consumed in 24 weeks will contain of albuminous matter 516 lbs.; that in the turnips with straw is computed at 516·60.

These enquiries tend to show that the increase of oilcake and other substances, rich in albuminous matter, in the more advanced stages of feeding, has no other effect, *so far as the nitrogenous element is concerned*, than to enrich the manure; they tend likewise to show that the gain of weight in fattening is much more due than has hitherto been supposed, to the oil and other respiratory or fat-forming ingredients of the food.

I compute the gain of fat per week as consisting of—

	lbs.
Loose fat, or tallow	3
Suet, or fat in the loin	1
Fat mixed with meat and sold as beef	7
	11

Nor do I think this an over-estimate, as it will be admitted that the gain of carcase fat, independent of the loose fat or tallow, is greater than that of flesh. The whole of the exterior of the carcase immediately under the skin is covered with a layer of fat, which, when the beast is lean, scarcely exceeds $\frac{1}{8}$ to $\frac{1}{4}$ inch in thickness, whilst in fattening it increases frequently to $1\frac{1}{2}$, *i. e.* sixfold or upwards. The fatty portions throughout increase also, and the flesh becomes intermixed with fat, and assumes what is termed the mottled appearance, which is the characteristic of beef of prime quality.

The 24 weeks will then show an increase of 264 lbs. of fat. As the oil in the turnips and straw is computed to be only 71·65 lbs., there does not remain a doubt on my mind that the greater proportion of fat stored up in this course of feeding is derived from the starch, sugar, &c.

In computing the proportion of fat derived from starch, a different relation obtains from what is observed in its efficacy for respiration, owing to the greater percentage of oxygen in starch and sugar as compared with that in oil, oxygen being required in much larger quantity than carbon or hydrogen in the respiratory process.

	Oxygen.	Carbon.	Hydrogen.
Starch and sugar contain on an average ..	51·36 ..	42·23 ..	6·41
Fat or oil	10·13 ..	78·13 ..	11·74

The proportion of carbon to hydrogen in each is very similar, being somewhat less than 7 of carbon to 1 of hydrogen, from which it appears that nearly 2 lbs. of starch are requisite to make 1 lb. of solid fat, or about 90 of starch for 50 of fat.

Physiologists attribute to fat, besides the maintenance of heat, the property of facilitating digestion. Lehmann describes fat as one of the most active agents in effecting the metamorphosis of food, and confirms this by his own experiments, and others by Elsässer.

It seems probable that the English feeder in fattening his cattle, and the foreign cook who saturates the lean-fed beef of his country with olive-oil, are alike unconsciously pursuing the same object—that of rendering their material more easy of digestion, and consequently more palatable.

In my treatment of *dairy* cows I find it advantageous to supply, in addition to ordinary food, materials particularly rich in albuminous matter, and to give more in proportion to those cows which give the largest yield of milk.

My conclusions in regard to *fattening* are, that by ordinary food you can afford an adequate supply of albumen for the maintenance and likewise for the increase in assimilation of fibrine, and that the gain by fattening is in a great measure due

to the starch, sugar, and other fat-forming principles, in which I include oil: without a due proportion of oil I should not expect success in fattening.

Value for Feeding purposes of various articles of Food.—I now propose to examine the composition of materials chiefly used for feeding, and their efficacy for the production of fat. I give the percentage of starch, sugar, &c., and reduce them to fat, taking the proportion as 90 of starch, sugar, &c., to 50 of fat. I supply likewise the percentage and value of their fertilizing constituents, which are of importance to the farmer and feeder. The computations were made on the materials in their usual state of dryness, except in the case of turnips, which are taken as free from moisture, and therefore valued at 4*l.* 10*s.* per ton, = 10*s.* per ton in the natural state.

From the following tabular statement (p. 172) it will be found that in wheat-straw, for which I pay 35*s.* per ton, I obtain for 1*s.* 2½*d.* ·50 oil and 32 lbs. starch, or (the starch reduced as oil), 18½ lbs., available for the production of fat or for respiration. I know no other material from which I can derive by purchase an equal amount of this element of food at so low a price. The value of straw calculated as manure is 9*s.* 7*d.* per ton.

Swedish turnips, at 10*s.* per ton, give of oil and starch reduced as oil, 35 lbs., for 2*s.* 2¼*d.* In comparative nutritive value 10*s.* per ton is much too low an estimate.

Oil-cake, *beans*, *Indian-meal*, and *locust-beans* have been taken at the same price, viz. 1*d.* per lb., or 9*l.* 6*s.* 8*d.* per ton; any variation in their relative market value will alter the figures here given in the same proportion. Of the four, oilcake is found to be the cheapest at the same price, being much preferable to beans for fattening. The locust or carob bean, at the same price, is *much* the dearest.

In these computations the albuminous matter is calculated only on its value as manure. When assimilated in flesh or fibrine it has a higher value in proportion to its weight than fat, and it is on the due apportionment of materials rich in albuminous matter that our success in feeding cattle with profit in great measure depends. For the purpose of acquiring more precise information I availed myself of the assistance of Professor Way, who selected for analysis a piece of beef *particularly lean*, and reported it to consist of—

Water	53·81
Fat	3·10
Albuminous matter	24·06
Other substances	19·3
	100·00

Cost and Composition of 100 lbs. of the following Substances used for Feeding:—

—	Cost.		100 lbs. contain									Value of Nitrogen, Phosphoric Acid, and Potash.	Deduct Nitrogen for perspiration.	Net Value for Manure.
	Per ton.	Per 100 lbs.	Oil.	Starch, Sugar, &c.	Oil, Starch, &c., computed as Oil.	Nitrogen.		Phosphoric Acid.		Potash.				
						Weight.	Value.	Weight.	Value.	Weight.	Value.			
	£. s. d.	s. d.	lbs.	lbs.	lbs.	lbs.	d.	lbs.	d.	lbs.	d.	s. d.	d.	s. d.
Meadow-hay	4 0 0	3 7	2·68	39·75	24·63	1·48	10·62	·90	1·35	1·50	4·50	1 4½	2 1/12	1 2¼
Wheat-straw	1 15 0	1 7	·50	32·	18·50	·42	3·	·14	·21	·65	2·16	0 5	¼	0 5
Swedish turnips . .	4 10 0	4 0	2·	60·	35·	2·40	17·28	·80	1·20	2·25	6·75	2 1¼	3½	1 9¾
Oil-cake	9 6 8	8 4	12·	38·	33·	5·	36·	2·25	3·37	1·75	5·25	3 8½	7¼	3 1¾
Beans	9 6 8	8 4	2·	42·	25·30	4·45	32·	·86	1·29	1·11	3·33	3 0½	6½	2 6
Indian meal	9 6 8	8 4	7·	60·	40·	2·25	16·20	·19	·28	·17	·51	1 5	3¼	1 1¾
Carob or locust bean .	9 6 8	8 4	6·76	57·	35·	·64	3·75	No analysis of ash.				say 0 5¾		0 5

Cost of Fat derived from 100 lbs. of the following Feeding Substances:—

	Meadow-hay.	Wheat-straw.	Swedish Turnips.	Oil-cake.	Beans.	Indian Meal.	Carob Beans.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cost of 100 lbs.	3 7	1 7	4 0	8 4	8 4	8 4	8 4
Deduct net value of manure . .	1 2¼	0 5	1 9¾	3 1¾	2 6	1 1¾	0 5
Cost for production of fat. . . .	2 4¾	1 2	2 2¼	5 2¼	5 10	7 2¼	7 11
Oil and starch, &c., computed as oil in lbs.	24·63	18·50	35·	33·	25·30	40·	35·

This material, though of its kind particularly rich in nitrogen, is not worth more as *manure* than 2*s.* 6½*d.* per 100 lbs., or less than one-twentieth of its value as *food.*

These investigations, which have more or less occupied my attention for several years, have changed considerably my mode of treatment for fattening. I am satisfied that the *most economical* use of food rich in albuminous matter is together with straw or other materials which are deficient in this element. I now use for fattening, *bean* and *oat-straw* and *shells of oats* in equal proportions, with a limited supply of *turnips*, never exceeding 60 lbs. per day to each, and the following extra food :—

3 lbs. of rape cake	.. ..	steamed together with the straw.
¾ lb. malt combs	.. ..	
¾ lb. bran	.. .. ..	

If my turnips fail in spring, by supplying 2 to 2½ lbs. of rape-cake in addition I find the result equally favourable. On this fare my cattle thrive satisfactorily, and make usually at the rate of 14 lbs. per week each. I sometimes substitute ½ lb. per day of linseed-oil for the 2 lbs. of rape-cake without turnips, the gain by which I find satisfactory. One of a lot of 14 fed in this mode gained at the rate of 24 lbs. per week from March up to July, 1856, being the greatest gain I have observed in the course of my experience as a feeder.

Having received numerous applications from vendors to become a purchaser, and inquiries as to what I thought of the properties of carob or locust beans, I may call attention to its comparative composition with Indian meal, which it most nearly resembles, and in comparison with which its value is decidedly inferior. There is little difference in the feeding effects of sugar and starch; the former contains somewhat more of oxygen, which in some slight degree facilitates its consumption in the respiratory process; but in the same ratio it is deficient in carbon, and has consequently less of the property of producing fat.

The respective quantities of oxygen from the air required for the consumption of

100 parts of starch are	.. ..	118·52
,, sugar	.. ..	106·67
,, fat	.. ..	292·14

These numbers seem to denote the comparative labour or exercise of the organs of respiration requisite for the consumption of these elements of food respectively, or, in other words, for the support of vitality. Their relative composition is—

	Carbon.	Hydrogen.	Oxygen.	
Fat	78·13	11·74	10·13	per cent.
Starch	44·45	6·17	49·38	
Sugar	40·	6·66	53·34	

Whilst these analyses have been in the course of preparation, with the view of being inserted in the Society's Journal, another month has elapsed, during which I have proceeded with my observations on dairy produce. On the 12th of March I purchased Mr. Smith's cow (see p. 153) for 12*l*. 10*s*., being more than her market value, for the purpose of trying her on my food; her yield of milk had then diminished to 8 quarts per day. On the 31st of March, four weeks from the former weighing, and nineteen days after being treated with my food, her yield of milk had increased to 9½ quarts per day, and her weight to 8 cwt. 1 qr., being 28 lbs. increase.

Mr. Pawson's cow, which was continued on the same food, viz., meadow-hay *ad libitum*, and a more limited supply of turnips, reduced her yield of milk to less than 5 quarts per day, without alteration in her weight.

My cow first placed on trial with those of Mr. Smith and Mr. Pawson, gave a yield of milk of 12 quarts per day, and gained 28 lbs. in the four weeks, her weight on the 31st of March being 10 cwt. 2 qrs.

The weight and the yield of milk of the six, on the 31st of March, were—

	March 4.			Yield of Milk per Day.	March 31.			Yield of Milk per Day.	Gain in 4 Weeks.
	cwt.	qrs.	lbs.	Quarts.	cwt.	qrs.	lbs.	Quarts.	lbs.
Weight of No. 1. ..	10	0	26	8	10	3	0	8·9	58
" 2. ..	11	1	0	14	11	3	0	14·9	56
" 4. ..	10	0	0	14½	10	1	0	13	28
" 6. ..	10	3	0	14	11	2	0	12	84
" 7. ..	11	0	0	10	11	3	0	10	84
" 11. ..	9	2	0	11	10	1	0	12	84

On referring to the previous weighing, there was little or no gain from Feb. 4th to March 4th, the cows being at that time in a somewhat more relaxed state. During March they wholly regained their consistency. The gain shown in the weighing, March 31, by the six cows, appears therefore unusually great. It should however be computed as made during the eight weeks, from Feb. 4th to March 31st, being with an average yield of nearly 12 quarts (11·66) per day each, at the rate of 8⅙ lbs. each per week on the average.

No. 11, it will be observed, is stated as giving more milk on the 31st than on the 4th of March. It occasionally happens that cows drop their yield of milk for a day or two, and then regain it, especially when in use. The whole of these six cows were kept free from calf till February, when Nos. 2 and 4 were sent to the bull. I had some hesitation in regard to No. 4, from her

having suffered from pleuro. Her milk, tested by a lactometer, denoted a less than average proportion of cream; still in quantity, and keeping up its yield for a length of time, being of more than ordinary capability, I decided to retain her.

Nos. 1 and 7, which are giving respectively 8 and 10 quarts per day, are in a state of fatness; they will probably be sold in June as prime fat, when their yield of milk will probably be 6 and 8 quarts per day each. They may be expected to fetch 20*l.* to 23*l.* No. 6 is also in a state of forwardness. No. 11, which suffered considerably from pleuro, is in comparatively lower condition.

During the season, from the close of October to the close of January, I avoid purchasing near-calving cows, which are then unusually dear, my replenishments being made with cows giving a low range of milk and intended for fattening: I find them more profitable than those which are quite dry. The present season I had additional grounds for abstaining from buying high-priced cows from the recent presence of pleuro.

On the 2nd of March I had occasion to purchase a calving cow, which was reported to have calved on the 28th of February. Her weight on the 4th of March was 9 cwt. 1 qr. I supplied her with 35 lbs. of mangel, and hay *ad libitum*, of which she ate 22 lbs. per day. The greatest yield she attained was somewhat more than 13 quarts per day. On the 31st of March her weight was 9 cwt., being a loss of 28 lbs. in four weeks. Her yield of milk had diminished to 11¼ quarts per day: a week after this her milk, during six days, was kept apart, and averaged 10 quarts per day; being at first rather more, at the close rather less, than this. The cream produced from these 60 quarts was 9 pints, the butter 63 oz. The butter from each quart of cream was 14 oz. The proportion of butter to milk was 63 oz. from 60 quarts—rather more than 1 oz. per quart.

An equal quantity of milk from a cow (calved Oct. 8th) treated with steamed food, and set apart for comparison, gave less than 7 pints of cream, which produced 79 oz. of butter.

In quality and agreeableness the butter from steamed food and cake was decidedly superior to that from hay and mangel.

Mr. Stansfeld, of Chertsey, has supplied me with the following interesting particulars of two Alderney cows which were treated as follows:—

	Rape-cake.	Bean-meal.	Bran.	Malt-combs.
	lbs.	lbs.	lbs.	lbs.
From Dec. 1st to Jan. 15th with swedes and meadow-hay.				
From Jan. 15th to Feb. 17th, pulped and fermented swedes, meadow-hay, and ..	3	2	2	2
From Feb. 17th to May 1st	5	..	2	2

Results :—

Dec. 1st to Jan. 15th, yield of butter from each quart of cream 10¾ ozs.
Jan. 15th to Feb. 17th ditto ditto 14 ozs.
Feb. 17th to May 1st ditto ditto 18⅔ ozs.

The yield of butter in proportion to milk, Dec. 1st to Jan. 15th, is described as unsatisfactory.

Ditto ditto Feb. 17th to May as 2 ozs. per quart, which is their maximum proportion.

Soon after calving the two cows give 18 quarts of milk per day; on the 15th of May 15 quarts per day.

Mr. Stansfeld has completely satisfied himself that by the process of fermentation the turnip loses its disagreeable taste, and that his butter is of excellent quality.

If I take the supply of turnips, 120 lbs. per day, as requisite for the maintenance only of the cow, the nutritive elements will be—

	Albumen.	Oil.	Starch and Sugar.
	1·98	·264	7·92
Reckoning the oil as used for respiration, and computing it in proportion of 5 to 2 as compared with starch = ...			·66
			8·58

The food supplied to the cow consists of—

	lbs.	Water.	Dry.	Albumen.	Oil.	Starch and Sugar.	Fibre.	Minerals.	Phosphoric Acid.
Hay	22	2¼	19·36	2·03	·59	8·74	6·05	1·95	·30
Stored Mangel	35	28·0	7·	1·05	..	4·20	1·05	·70	·05
			26·36	3·08	·59	12·94	1·10	2·65	·35

	Oz.
The 13 quarts of milk yielded of butter ..	13·60
Deduct for moisture, &c.	2·28
	11·32
Butter in the skimmed milk estimated as ..	·68
	oz. 12·00
12 ounces of pure oil in the butter are ¾ lb. =	·75

		lb.
The oil in the food		·59
The starch and sugar	12·94	
Used for animal respiration ..	8·58	
		4·36

There appears, then, in this supply of food ·59 lb. oil and 4·36 lbs. starch for the production of ·75 in the butter from 13 quarts per day, the cow's greatest yield. At the time the milk was tested, aftermath hay was substituted for first-crop hay, in equal

quantity. This, it will be observed, is decidedly richer in oil. Her produce had lessened to 10 quarts per day; her production of butter was 10·50 oz. per day, or of pure oil about 9 oz.; for the supply of oil the aftermath hay alone would be much more than adequate.

On examining the adequacy of the food for the supply of albumen for the casein,

	lbs.
I find this to be	3·08
I assume that in 120 lbs. of turnips, as required for maintenance, in a normal state	1·98
	1·10

Which, according to Haidlen's analysis, will be adequate to the supply of 8·60 quarts per day. The supply of mineral substances is in excess.

The cow under this treatment gave—

Soon after calving fully	13 quarts per day.
5 weeks after calving	11¼ ,,
In less than 8 weeks after calving ..	9 ,,

and with this there occurred also a loss of weight.

We find this cow, supplied with food amply rich in every element suited to her wants and purposes, with the exception of the nitrogenous principle only, lowering her condition, and likewise her yield of milk till it approaches a quantity for which her food enables her to supply a due proportion of casein.

About the 20th of April the cow's yield being reduced to 9 quarts per day, her food was changed to steamed mixture; soon after this her yield increased to 11 quarts per day. Her weight, April 28th, 9 cwt.; May 16th, 9 cwt. 14 lbs., yield of milk 11 quarts.

I now introduce the dairy statistics of Mr. Alcock, of Aireville, Skipton, who has for some time been practising my method of treatment, with such modifications as are suited to his circumstances.

During the winter season Mr. Alcock's food consisted of mangel, of which he gave 20 lbs. per day to each, uncooked; together with steamed food *ad libitum*, consisting of wheat and bean straw, and shells of oats.

	lbs. per Day.
Carob bean and Indian meal, for each	3
Bran and malt combs	1¾
Bean meal	3½
Rape cake*	3
Of extra food	11¼

* The rape-cake used by Mr. Alcock was of foreign manufacture, evidently rich in oil, but containing mustard, and on this account supplied in less proportion.

From March 19th, when his store of mangel was exhausted, he increased his supply of Indian meal to 4 lbs. per day, and omitted the carob bean.

During the month of January Mr. Alcock obtained from 759 quarts of milk 1323 oz. of butter, being from each 16 quarts $26\frac{5}{8}$ oz. During February and March, from 7368 quarts of milk, 12,453 oz. of butter, or from each 16 quarts fully 27 oz.; so that rather less than $9\frac{1}{2}$ quarts of milk have produced 16 oz. of butter. The average produce from each quart of cream was $20\frac{1}{2}$ oz.

Mr. Alcock fattens his cows whilst giving milk, and sells them whilst giving 4 to 6 quarts per day. He quite agrees with me that it is far more profitable to buy far-milked cows for fattening; and obtains, from a change to his food, 2 to 3 quarts per day more than the cow had given previously.

Though Mr. Alcock's cream is not so rich as what I have described in a former Journal, it is more than ordinarily so. His mode of separating his milk from his cream differs from my own, his milk being set up in leaden vessels, from which, on the cream being formed, the old milk is drawn, by taking a plug from a hollow tube with perforated holes in the centre of the vessel. To this difference I am disposed in some degree to attribute the less richness of Mr. Alcock's cream. On examining the cream with a spoon, after the dairy-keeper had drawn off the milk, I observed some portion of milk, which would have escaped through my perforated skimmer.

Mr. Alcock's proportion of butter from milk, which is the matter of practical importance, is greater than what I have shown in a former volume of this Journal, being from each 16 quarts of milk 27 oz. of butter.

Quality of Butter.—In January, 1857, samples of about 56 oz. each of butter of my own, and also of Mr. Alcock's, were sent to the laboratory of Messrs. Price and Co.'s candle works at Belmont:—

My butter was found to consist of (taking the pure fat only)—

Hard fat, mostly margarine, fusible at 95°	45·9
Liquid or olein	54·1
	100·0

Mr. Alcock's—

Hard fat, mostly margarine, fusible at 100°	36·0
Liquid or olein	64·0
	100·0

For these analyses of butter the agricultural public are indebted to the good offices of Mr. George Wilson, director of Messrs.

Price and Co.'s manufactory. It will be observed that Mr. Alcock's milk is richer in butter, and that his butter is also richer in proportion of olein to margarine than my own.

Professor Thompson ('Elements of Agricultural Chemistry,' 6th edition, p. 317) states that winter butter consists more of solid, and summer more of liquid, or olein fat.

An analysis of butter made in Vosges, gives—

	Summer.	Winter.
Solid or margarine fat	40	65
Liquid (or olein) fat	60	35
	100	100

In Lehmann's 'Physiological Chemistry' (Leipsic edition, vol. ii. p. 329) an analysis of butter by Bromus, gives—

Margarine	68
Olein	30
Special butter oil	2
	100

It will be observed that my butter may be classed as summer butter, and that Mr. Alcock's is the richest in proportion of olein. Both were produced in the month of January.

These results are important, and completely establish the conclusion I had previously formed, that the quantity and quality of butter depend essentially on the food and treatment; and that by suitable means you can produce *as much and as rich butter in winter as in summer.*

From information derived from various sources in the district in which the same breed of cows is kept, the average quantity of butter from milk is somewhat more than an ounce to each quart, or from 16 quarts of milk 17 to 18 oz. of butter. This is during summer, and whilst the cows are at grass.

During the winter season the supply of butter from the dairy-keepers in this vicinity falls off to one-fourth of what they produce in summer.

I am led to infer that there is some misapprehension as to what forms the excellence of butter. On inquiring of a Jermyn-street factor, I learnt that rich oily butter is preferred in winter, and hard butter in summer. This preference to hard butter in summer will doubtless be owing to its withstanding better the effects of heat, and consequently being more palatable.

It seems probable that the higher price of butter, in comparison with that of suet or other solid fat, is due not only to its agreeable flavour but also to its proportion of olein, which is known to be more easy of digestion, and more available for respiration than solid or margarine fat. We find it preferred for pastry

and other culinary preparations, in which its peculiar flavour disappears; the essential oil in which this resides being very volatile and easily removed by cooking or exposure to frost.

Olive oil, which amongst the vegetable oils has the greatest proportion of olein (72 to 28 margarine), is much used in culinary preparations, especially on the continent. Any one who has partaken of a beef-steak nicely prepared with refined olive oil in the cuisine of a first-rate foreign hotel, will scarcely detect the substitution of this oil for butter.

The price of refined olive-oil to consumers is about equal to that of butter; whilst that of linseed oil, rape, &c., ranges at from 4*d.* to 5*d.* per lb.

Use of Rape-cake.—Having had considerable experience in the use of rape-cake as food for cattle, I offer some suggestions to those who have been less accustomed to it, my consumption of this material for dairy cows and for fattening being upwards of twenty tons per year.

When I first gave an order to the manufacturer with whom I chiefly deal, about six years ago, on explaining to him the purpose for which I required it he requested time for its preparation, and recommended that I would give him, at the time the fresh seeds arrived, an order to the extent of my requirements for the year. As the quantity I ordered fell short, I sent for a further supply without notice; on its arrival I was not satisfied with its appearance or effects. On making a complaint, I was reminded by the manufacturer of his request that I would give him previous notice. He then explained that his object was to select seed free from mustard or other impurity. Since then I have had no occasion to find fault with the cake from this manufacturer.

A sample of this was found by Professor Way to contain, of

Moisture	8·49
Woody fibre	8·61
Starch, gum, sugar, &c. ..	37·93
Albuminous matter	31·42
Oil and fatty matter	10·65
Ash	2·90
	100·00

I have occasionally bought German or Danish rape-cake; it is made up in thick square pieces of a rich green colour, and not so hard pressed. An analysis of this by Professor Way gave, of albuminous matter 30 and of oil 13·16 per cent. Until this season I had no grounds to find fault with this foreign cake, but was satisfied to pay for it a higher price, owing to its superior richness in oil. In this season's importation I was led to suspect some admixture of mustard-seed. On macerating a sample in tepid water, I perceived an admixture of yellow husks, and like-

wise the smell peculiar to mustard. More completely to satisfy myself, I sent a sample to Professor Way, who reported it to contain mustard.

As dealers now charge a higher price for this material, for food, in comparison with what they charge for it as manure, they are clearly responsible for its being of a quality suitable for food.

To prevent the cake becoming mouldy, I cover it over with shells of oats which have been kiln-dried; chopped straw, if dry, would equally serve the purpose; by this means its flavour is also preserved—indeed, by keeping for a time, I find it become milder in taste, and more easy to masticate.

Management of Grass-land.—In describing the crops or produce adapted for dairy purposes, I think it proper to notice my treatment of permanent grass, meadow and pasture. I reside on the borders of a district in Yorkshire, over which you may travel 50 or 60 miles without seeing, except here and there, an isolated patch in tillage, and I am enabled to state, from observation, that in this extensive tract of permanent-grass the occupiers depend almost wholly on the excrement of their cattle for maintaining the fertility of their land. Whilst in some of the corn-growing districts the farmers purchase guano or other extra manure, at the rate of 20*s.* per acre over the whole of their holdings, by far the majority of those in the district I am speaking of (from which a continued deportation of cattle and also of dairy produce takes place), depend wholly for manure on the excrement from their stock, and do not replenish with extra materials.

As my own treatment of permanent grass differs materially from this, I proceed to describe it and its results.

My meadows, from their high condition, preserve their verdure through winter; during the month of March, and up to the first week in May, they afford excellent pasturage for ewes with their lambs, of which they carry at the rate of four per acre till the first week of May. Some portion is left untouched by sheep for early soiling, which I usually commence about the 26th of May.

From the 20th to the 30th of June my mowing for the main crop of hay usually takes place. The aftermath is again cut either for soiling or for aftermath hay, so that each meadow is mown twice during the season. After the second mowing a nice aftermath grows, which serves for the next year's ewes, which are bought early in October, and turned on the meadows together with their ram. Soon after the ground is clear, the weather being suitable (I prefer it cloudy or wet), the fresh excrement from the tanks under the tails of the animals is carted on and dressed in. The whole of my meadow land gets a dressing of this once a year. The excrement is quite free from straw. I

formerly procured peat soil to mix with it to neutralise the smell; but am at present using for that purpose scrapings which are carted on, free of charge, by the conservators of the roads. Both for soiling and as aftermath the grass thus dressed is eaten with relish.

I find little difficulty in getting manure of this kind into the ground. During warm, moist weather, when the absorbent powers of the soil are in full activity, the whole dressing soon disappears. I have known the cocksfoot-grass, the property of which for quick growth as aftermath is well known, attain a height of 3 feet in five or six weeks after mowing.

In addition to this yearly dressing with excrement, I apply guano at the rate of 2 cwt. to each acre. I do this usually in the spring. I have, however, thought that I derived equal, if not greater, benefit from its application in very wet weather in November. The growth during March was sensibly greater than on adjacent land on which the guano was not applied till April; and the main crop of hay was certainly not less than on that dressed in April.

Mode of Haymaking.—As the process of hay-making differs so much, and is in some districts so inefficiently performed, I venture to describe the method I am using, and to which I give my personal attention. No farm operation requires greater care than securing the hay crop.

Till lately I deferred mowing the grass till it was in flower. In the year 1856 I cut it before the flowering time. Though this early cut grass shrinks more in the stack, yet I find it weigh proportionately heavier. It is not unusual for a square yard cut from the solid part of one of my stacks to weigh 30 stone imperial: I have known it exceed this. The solid part of a small stack of aftermath hay from seven acres of this season's growth weighed 26 stones imperial. I find it of advantage to employ a full complement of haymakers. In travelling through the country I have seen but one haymaker employed where I should have half a dozen. I find six haymakers, if fully employed, earn their 12*s.* or 14*s.* for one day far better than a single man would earn the same sum in six days.

The haymaking or tedding machine has in my practice superseded the expensive operation of spreading by hand. When the grass has been spread a sufficient time, the haymakers turn it with their hand-rakes from the sun or wind. At the close of the day the grass or hay is raked together in rows; the space between each row is left quite bare. In this state it remains overnight, to prevent the bleaching effects of the falling dew and the moisture from the ground. Early in the morning, as soon as the bare ground between the rows is dry, the haymakers turn over the

rows, the under side of which, and the ground on which they have laid, are completely wet from checked evaporation. This operation of turning is easily performed, and well repays the labour. When the ground is dry the tedding-machine is set to work, and the turning and drying are repeated. When the weather is at all doubtful we resort to the lap or shake cock, in making which the haymaker gathers up an armful, say 8 to 10 lbs. of partly dried grass, and lets it fall lightly on a heap. He then thrusts his hands under the heap, lifts and folds it without pressing, and sets the heap quite lightly on the ground with the end towards the wind: in appearance it is not unlike a lady's muff of large size. It is a common saying, that well made lap-cocks will stand a fortnight's rain free from damage. Without subscribing to this, I have no hesitation in stating, that in no form does partly-dried grass keep so well as in lap-cock. The rain falling on a lap-cock is thrown off in a somewhat similar manner as from an umbrella. I never recollect finding a well-made lap-cock thoroughly wetted.

By the mode I have described I accelerate the process of haymaking; and it is by no means uncommon for me to secure my crop in less than half the time required by my neighbours. On the hay becoming sufficiently dry, it is formed into wind-rows and then drawn together by a sweep into large pikes of about three loads each, with conical tops which are slightly thatched with straw.* When the pikes have undergone a partial sweating, they are carted away and well intermixed in stacking. This pikeing before stacking I find quite necessary with my rich quick-grown grass to prevent over-heating. Early in the mornings, and at other intervals, when not occupied with haymaking, the men hoe and clean turnips, &c. Though this district is high and the climate rather wet, yet from 1847 up to the present time I have succeeded in carrying the whole of each crop in good condition.

In stating the produce per acre I give the ascertained weight of a great portion of the first crop, and the whole of the second crop, as weighed out of the pikes. The price of 6*d*. per stone, or 4*l*. per ton, is lower than the average value for a series of years in this district:—

Average weight of first crop, gathered in June, 1856,	$2\frac{1}{2}$ tons.			
Second, or aftermath, gathered first week in Sept. ,,	$1\frac{1}{2}$,,			
	4 tons =	£16	0	0
Pasturage from March to April, and in October and November ..		1	5	0
Gross produce of one acre of grass-land		£17	5	0

Estimating 1 ton of hay as equal to 6 tons of Swedish turnips,

* Thatching the pikes is unnecessary except in a district where more than an average fall of rain occurs.—Ed.

this produce of natural grass does not compare unfavourably with a root crop. One ton of well-gotten hay is, however, superior to 6 tons of Swedes, on account of its greater quantity of oil, which is without doubt one of the most valuable elements of food.

The meadows on which this produce is grown are on strong clay, which before draining yielded but a scanty herbage, interspersed with rushes, and but a light crop of hay late in July.

The following is my treatment of my permanent pastures, which are heavily stocked during the summer season. The home pasture, of barely 15 acres, carries my 20 milk cows during the day. They are housed during the night. This clearing the pastures by night has in some degree the effect of a change of pasture, and prevents their lying so much on the grass they eat. In addition to the 20 milk cows, 20 ewes with their lambs graze and fatten on this home pasture of 15 acres. These ewes are supplied with ½ lb. of rape-cake each per day. It will be observed that the dung from the cows is likewise enriched by the extra food given to the cows in stall. Several times during the season a labourer is sent round the pastures to spread about the dung: for this operation I prefer wet weather. My other pastures are also rich feeding pastures, and carry a beast and an ewe with her lambs per acre. During July and August the coarse tufts of grass in the pastures are mown and carried home for fodder for my horses. I prefer this pasture grass for horses to that from aftermath, which is too relaxing. These pasture mowings more than suffice for the bulky food for four or five horses during July and August. The surplus is partly eaten by the cattle, the remainder being converted into hay, and mixed with cut straw for steaming. After this mowing of the tufts, the pastures assume the appearance of aftermath, and the animals graze with appetite over the whole. Late in autumn and early in spring the ewes are continued on these pastures, which they graze quite close. They are housed during severe weather and at night on boarded floors, and turned on the pastures during the day through winter in fine weather.

To these frequent cuttings of my meadows, and close grazing of my pastures, I am in some degree indebted for the excellent quality of their produce.

My successful use of rape-cake as food has caused my attention to be given to the cultivation of the green rape plant for fodder, of which I produce two crops during the year. The sowing for one is made towards the close of June or early in July, after early potatoes, or on other vacant ground, enriched with the fresh excrement from my cattle. The produce from this sowing is cut towards the close of September, in October, and early in November. To ascertain the quantity, I measured out 400 square yards, which was cut in dry weather ; the produce

was upwards of $1\frac{1}{4}$ ton, being more than 16 tons per acre. This cutting was made before the crop had attained its full growth. The average over the whole would be more.

Towards the close of July or early in August I sow rape in a seed-bed, for which I use the headlands of crops which are horse-hoed. These plants are taken from the seed-bed and planted after lifting the potatoes in September or October, and produce a crop during the early part of May. Though the operation of planting out is somewhat tedious, yet the produce being available at a time when green food is scarce, I find its cultivation remunerative. My produce this season is equal to about 7 to 8 tons per acre. This spring crop is cut in time to be followed by cabbage and kohl-rabi.

The properties of green rape as food for sheep are well known. In Morton's Cyclopædia I find a complete analysis, showing it to be rich in flesh and fat forming constituents. Dr. Voelcker characterises it as richer in fatty matter than any other green crop used for food. During the month of October and early in November I give it both to my milk and fattening cows: they devour it with relish. I have as yet found no green crop equal to green rape at that season of the year.

In cultivating the cabbage and kohl-rabi, I find it advantageous to plant them in rows of 4 ft. to 4 ft. 6 in. apart, with potatoes between each row. As the potato forms its tubers and expands its foliage, whilst that of cabbage and kohl-rabi are comparatively small, I obtain an abundant crop of each. On the potatoes being lifted, the cabbages nearly cover the whole ground.

The produce of the cabbages exceeds that of any other vegetable I cultivate: yet on account of its flavour I limit its use to a less quantity than that of any other green food. The kohl-rabi, though not equally productive with the cabbage, is in flavour somewhat more agreeable.

Rotation of Crops.—The extent of land in tillage in my occupation being limited, my rotation is short, and consists of—

1st. Mangel or turnips, which are amply manured with fresh excrement from my cattle. I prefer ploughing this into the ground in all its freshness; but as this is not always practicable in the autumn, when used in spring I mix with it guano, at the rate of 2 to 3 cwt. per acre, for the purpose of accelerating its decomposition. With the view of satisfying myself of the effect of this, I mixed a small quantity of guano in a garden-pot filled with fresh excrement; the effect was soon perceivable from a strong effluvium and an appearance of gaseous bubbles, and a change to yellowness of colour, whilst a pot of excrement without guano in juxtaposition remained comparatively unchanged. This experiment was repeated in my vinery, at a temperature of 56°,

with a like result. Before I resorted to this I observed a comparative slowness of growth of the root crop after the application of the fresh excrement, which I do not now perceive.

My mangel and turnip crops average, from actual weighings, about 25 tons to the acre, that of mangel being somewhat the heavier.

The estimate of the value of either of these crops is usually made on what it leaves for profit, and reckoned at 8*s.* to 10*s.* per ton. This is a very unsafe rule: if taken on its quantum of nutritive matter, it assumes a different value; as dry material, you cannot obtain any concentrated food equally nutritive at less than 7*l.* to 8*l.* per ton, which would give 16*s.* to 20*s.* per ton as their value in the natural state.

The great proportion of water contained in these roots would however prove a serious drawback to their extended cultivation for sale at a distance. You can convey in hay six times, and in oil-cake or beans twelve times, the quantity of nutritive matter contained in turnips. A consideration of this has often reminded me of the great additional labour incurred by those who give turnips wholly as food to the amount of 170 lbs. to 180 lbs. per day. A feeder who maintains 100 head of cattle will be conveying at the rate of 23 to 25 tons weekly of superfluous water from his field, of which the effect will be to increase the bulk of his manure without adding to its value. Some small advantage is derived from the watery property of the turnip, particularly when stored, in consequence of its supplying beverage in a less chilling state than by cold water alone, from drinking freely of which in severe weather I have seen cattle seriously chilled.

My crop in succession to mangel or turnips is that of beans, which I prize highly for my purpose, affording as it does a large amount of the nitrogenous element. I have hitherto cultivated the common kinds of field-beans. On the recommendation of an acquaintance, who stated that I might reckon on a much larger produce from the long-pod or garden-bean, in 1856 I set out amongst a crop of field-beans an interval of 1670 yards for trial of the sword variety of long-pod beans. The produce was carefully weighed and found to be of—

Field beans, white blossom, 52 bus., of 63 lbs., at 5*s.*	£13 0 0
Straw, fully 2 tons per acre	4 0 0
	£17 0 0
Long pods, on 1670 yds. 1435 lbs. = 66 bus. of 63 lbs. per acre	£16 10 0
Straw, 1¾ tons per acre	3 10 0
	£20 0 0

The garden or long-pod beans having ripened a fortnight

before the field-beans, and having been left standing till the same time, had lost almost all their leaves. Their appearance, however, denoted a less weight of straw even if cut sooner than the field-bean. The price of bean straw, 2*l.* per ton, is low in proportion to its value in the analysis given in Vol. XVII., p. 263, of this Journal.

A sample of long-pod beans gave the following composition on analysis by Professor Way:—

Moisture	12·50
Woody fibre	4·35
Albuminous matter	28·25
Oil and fatty matter	4·05
Starch, gum, sugar	46·95
Ash	3·90
	100·00

On referring to the various analyses to which I have access, I find the comparison favourable to the long-pod, which has less of woody fibre in proportion of 4·35 to 10·20, with more of starch in proportion of 46·95 to 42, and more of oil in proportion of 4·05 to 2 per cent. than the common or field-bean. The cultivation of the long-pod is precisely similar to that of the common kinds. The seed is strewed in drills or otherwise dibbled in rows 2 feet apart. The horsehoe is applied several times between the rows, and every weed pulled up.

With the view of comparison I give the proceeds of my wheat crop of 1856. This is the third in my rotation, after which I again cultivate turnips or other green crops:—

	£	s.	d.
Average, 5 qrs. (63 lbs. per bushel) of wheat of good quality, at 62*s.*	£15	10	0
Inferior wheat	0	12	6
	£16	2	6
Straw, 38 cwt. per acre, 35*s.* per ton	1	13	9
	£17	16	3

I state the price I pay for straw for fodder; every cwt. contains about 40 lbs. of starchy matter available for respiration, which I obtain, together with a small percentage of albumen, for 1*s.* 9*d.* per cwt. or 35*s.* per ton.

Treatment of Milk-Fever.—Those of my milk cows which I retain for some time on hand are invariably in high condition, and on this account more liable to milk-fever. I think it pertinent to explain the method I use to prevent this malady. It is now six or seven years since I lost a cow from milk-fever. On conversing on the subject with a gentleman who had been on a visit to Mr. Fenton, who kept a considerable number of dairy cows near Rochdale, he described to me the

means used by that gentleman, which, with probably some modifications of my own, I have since continued to apply. No difference is observed in the cow's treatment or food till the symptoms of calving appear. Her supply of water is then limited to about one-half of what she would drink. When she has calved, and for two days afterwards, she is plentifully supplied with a quantity of oatmeal gruel twice per day, with about 2 lbs. of treacle each time in the gruel. No water is given separately; she is allowed her ordinary food. After calving she is milked every 3 to 4 hours for two days or upwards. The attendant is enjoined not to strip her milk clean, but leave a little in her udder, in the manner he would use in drying a cow of her milk. When two to three days are over, she is supplied with water and food *ad libitum*, and the ordinary process of milking clean twice per day resorted to.

The only instance of milk-fever since I adopted these precautionary means occurred in 1855, under the following circumstances. I bought a cow in July to calve in September; her appearance denoted good milking properties. She dropped her calf whilst out on pasture, and without giving the previous notice by filling the udder, or showing symptoms of giving much milk. I then told her attendant he need not use the precaution, but supply her with food and drink to promote her secretion of milk. Within two days of her having calved, the feeder came to me with the intelligence that she had dropped. On arriving at her stall, I found her case a decided and severe one. Having collected a sufficient number of assistants, together with our village druggist, Mr. Holden, who on occasions of emergency was called in to assist and on this occasion was the chief adviser, we resorted to the appliance of bags filled with the hot steamed food, of which there was a plentiful supply in readiness. These were placed along her spine and sides, and on cooling replaced with others; this operation was continued from noon till evening. During the same time men were continually engaged (relieving each other) in squeezing from her teats what little milk they could. The bags of hot steamed food had the effect of inducing a profuse perspiration. A dose or two of sulphate of magnesia were given, then linseed oil, but without effect; after this treacle with brandy in half-pint doses, to the extent of 10 to 12 lbs. She was several times pierced with the trocar to relieve her from gas by which she was distended. Aperient medicine was also given. The symptoms of the malady began to abate in the evening. Early next morning she was still lying, her pulse quite feeble, and other appearances of languor. On being supplied with a wineglass full of brandy in some warm gruel, she raised herself on her feet, and recovered.

Pleuro-Pneumonia.—During the year 1856 pleuro-pneumonia prevailed to some extent in the neighbourhood, more especially amongst the dairy cows about Leeds. Its first appearance in my immediate vicinity was in the herd of my next neighbour, who lost several, and sent others off immediately for slaughter—in all 16 to 18. Towards the close of July, and during the hot weather of August, my own herd of cattle, more especially my milk cows, were also attacked. I sent some few off which were in a forward state of fatness; the return for these being small in proportion to their value for milking, together with the unpleasant idea of sending off animals at all ailing for slaughter, influenced me to use every means for their restoration, and to give their treatment my best attention. At first my treatment underwent various modifications, and I lost two cows. Without describing the change, I proceed to supply particulars of the treatment I afterwards adopted, and which I have since continued with little alteration.

My feeders are strictly enjoined without loss of time to report to me any appearance of ailment, a practice I strenuously recommend to any one who concerns himself about the treatment of his cattle when sick, more particularly as regards the disease of which I am speaking, the chance of success in which depends essentially on early application.

The first appearance which arrests the feeder's attention is loss or partial loss of appetite. If on examination I detect any of the symptoms which characterise pleuro, viz., cough, quickness or deepness of respiration, loss of cud, and acceleration of pulse, intermittent warmth and chillness of horns and feet, I proceed at once to bleed till the pulse is sensibly affected: this requires usually 5 or 6 quarts to be taken. I then give—

Epsom salts	8 oz.
Sweet spirits of nitre	1 oz.
Tartar emetic	½ drachm.
Digitalis	½ drachm.
Flour of sulphur	4 to 6 oz.
Treacle	16 oz.
Cocoa olein	6 oz.

These ingredients are mixed and given in plenty of warm gruel, for which I use my pig food, boiled Indian-meal with about one-fourth proportion of pea-meal. On a renewal of the difficulty of breathing or acceleration of pulse, I repeat the bleeding to a less degree, say 3 quarts, and give likewise the tartar-emetic and digitalis in the gruel.

I continue to give, morning and evening, in gruel—

Sweet spirits of nitre	½ oz. to 1 oz.
Flour of sulphur	4 oz.
Treacle or sugar	8 oz.
Cocoa olein	4 to 6 oz.

At noon I give gruel, with addition of a little sugar only. The doses of treacle and sulphur are modified so as to keep the bowels moderately open. It will be observed that I give Epsom-salts as the first dose, on account of their quick action, but afterwards I prefer treacle with sulphur. The patient requires watching with the greatest care. The sick room ought to be well ventilated at the top, but kept warm day and night; a depression of temperature or a draught has been observed to disturb the breathing. When the feverish symptoms have abated I give oatmeal instead of Indian-meal in the gruel. I continue the cocoa olein in the gruel throughout, with doses of $\frac{1}{2}$ oz. to 1 oz. sweet nitre, and 3 to 4 oz. of flour of sulphur. In several cases, when the pulse has become feeble, and below 60 beats per minute, accompanied by weakness and languor, I have given a wine-glass full of brandy in the morning's and evening's gruel with apparent advantage. The attendant is instructed to offer the animal change of food—brewer's grains, bran-mash, a little hay, grass, green rape plant, or other palatable material. It is encouraging to find the animal begin to eat and make its selection of food.

Since I used the precise treatment I have described, upwards of twenty in succession have recovered. In this number I include those belonging to my neighbours who have used the same means under my advice and direction.

The time the cattle have been unwell has ordinarily varied from 14 to 21 days; some have exceeded this. The healthy action of the skin is stimulated; the animals continue to lick themselves with little intermission throughout; they likewise retain or otherwise resume their cud, under conditions I should not have expected; frequently when supplied only with the gruel and its ingredients, with not more than a pound or two of hay per day, I have observed them cudding.

They have lost in live weight $1\frac{1}{4}$ cwt. to $1\frac{3}{4}$ cwt. A considerable portion of this will doubtless be in bulk from the use of the purgative medicines. The milk cows, whilst suffering, have reduced their yield of milk from 2 to 4 quarts per day; but on recovery have almost wholly regained their former quantity. In no instance have I found a greater diminution than what might have been expected from the loss of condition and of time.

The cocoa-olein is prepared in Messrs. Price and Co.'s candle manufactory expressly for cattle, being lower in price than what is used by medical practitioners.

In a conversation with Mr. Garnett, of Clitheroe, I learnt that some time ago he purchased eight or ten polled Galloways from a lot of 50 which were exposed in a market for sale. Nine weeks after this they became affected with pleuro-pneumonia, from which he lost the greater part of them. He afterwards

learnt from the dealer from whom he bought them that the remainder of the herd of 50, which were sold to six or eight parties who resided at a distance from each other, were also affected with the disease in the same week and with the like result.

From this, to which numerous instances similar in character may be added, we may infer that the origin of the disease is somewhat remote. The 50 Galloways being nearly the same age would have been purchased from various breeders, and sent together from Galloway to Clitheroe, a distance of 150 miles. It seems not improbable that from exposure to a sudden change of temperature to which they were subjected after they had been collected together by the dealer, the process of respiration has been impeded, by which some impurity of the blood is engendered, which slowly and imperceptibly increases until the symptoms I have described attract attention.

Cattle from Ireland are more subject to this complaint than others; they are brought on board vessels, crowded together in the hulls or on the decks, and on reaching land travel usually on foot considerable distances to markets for sale.

My milch cows are housed during winter in stalls of more than ordinary warmth, and are turned out to grass in the month of May, which in the season 1856 was unusually wet and changeable; the pleuro has prevailed among them since July. At the commencement of this illness, the feeder states that up to the meal before the cow has eaten up her food, given her usual yield of milk, and shown every symptom of health; thus though the disease has hitherto been imperceptible and of slow progress, it arrives at a stage to cause a sudden interruption of the functions, the cow's appetite is gone, and her yield of milk diminished to one-half of what she gave 12 hours before.

On applying the ear to the side of the animal you distinctly hear the air rushing past, but at the very early stage, as far as the ear can detect, with little or no impediment; the inhalations become frequent and laboured. On opening the vein if you place your finger in the stream of blood a hot sensation is imparted: if you again place your finger in the stream towards the close of bleeding, the heat is sensibly diminished; the colour of the blood also undergoes a perceptible change from a dark to a redder or brighter colour.

A consideration of these symptoms seems to denote a greater consumption of carbon, for the combustion or oxidation of which it seems probable that the animal is prompted to exert her organs of respiration for the supply of the necessary air, whilst the blood at the same time is in an impure state. At this stage immediate relief seems requisite to prevent or arrest damage from over-exertion; with this object I resort to bleeding

as the speediest means of subduing the fever and lowering the circulation. Tartar emetic and digitalis are known also to have the effect of retarding the circulation and lowering the pulse. It will be observed that I apply these necessarily in the very early stages; spirits of nitre and flour of sulphur, which are continued much longer, stimulate the secretions, and thus tend to purify the blood and the system. My observations lead me to think that the organs of respiration are on the first appearances, comparatively speaking, but slightly injured. It is not until after a lapse of time that with the ear we can perceive that dulness of sound which betokens injury. In the two which died we could distinctly trace the increase of this, until the flow of air on the one side seemed entirely to have ceased, whilst on the other we could plainly hear the air passing to and fro. On a *post mortem* examination we found the lung on one side completely damaged, whilst on the other it was but little affected. Whilst the greater heat of blood and the more frequent respiration denote an excessive demand on the carbon, yet at the same time the animal is devoid of appetite; the necessary consequence is a consumption of the components of the system. The fats will first be laid hold of, then, though probably not altogether singly and separately, the carbonaceous components of the fibrine, but as these materials are in succession less easily available, their consumption seems necessarily to imply a greater exertion of the organs of respiration.

These considerations have led me to resort to a supply of food rich in elements of heat, carbon, and hydrogen, in a form easily available for respiration. Indian meal is particularly rich in starch; by the process of boiling it approximates more nearly to sugar; together with this I give sugar and treacle in appreciable quantities, and also oleine oil. These ingredients are mixed and given in warm water. Starch, sugar, gum, dextrin, &c., are accounted the main supporters of the heat of animals when in health; they contain with carbon and hydrogen a considerable proportion of oxygen. On this account they require less of the oxygen of the air to effect their combustion. Their components are:—

	Carbon.	Hydrogen.	Oxygen.
Starch	44·45 ..	6·17 ..	49·38
Sugar	40·00 ..	6·66 ..	53·54

The composition of oils differs very considerably from that of starch and sugar, oils being much richer in carbon and hydrogen with less of oxygen. They contain on an average of analysis:—

	Carbon.	Hydrogen.	Oxygen.
Oil or fat	78·13 ..	11·74 ..	10·13

The following are ultimate analyses by Dr. Dugald Campbell, given in Dr. Thompson's lectures (p. 34):—

	Carbon.	Hydrogen.	Oxygen.	Nitrogen.
Cod liver oil ..	80·18 ..	13·72 ..	5·854 ..	·246
Olive oil	69·38 ..	13·47 ..	17·092 ..	·058

A proximate analysis by M. Braconnot of olive oil, one of the vegetable oils richest in olein, gives—

Of Olein.	Margarine.
72	28

Vegetable oils or fats are observed to be much longer in undergoing digestion, and in their passage through the system, than the other elements of food. They contain in the same space the greatest proportion of elements necessary for the support of vitality, according to Lehmann, whose work I have recently been able to obtain, the first and second volumes in German, the third in English. I find in vol. iii., page 358, the following computation:—"If in a given time the organism absorbs 100 grammes of oxygen, the following quantities would be necessary, in union with 100 grammes of oxygen, to satisfy the requirements of vitality;—Of fat, 34·23 grammes; starch, 84·37 grammes; sugar, 93·75. From which it will be seen that a pound of fat or oil in combination with the oxygen supplied by the air is equal to nearly 3 lbs of starch or sugar."

Lehmann, vol. iii., pp. 336 to 339, gives a series of interesting experiments by Vierordt, who found the mean or his average respirations whilst in a state of rest to be 12 per minute, by which he expired 366 cubic inches of air containing 13·5 cubic inches of carbonic acid; by increasing his respirations to 96 per minute he expired 2928 cubic inches, containing 79 cubic inches of carbonic acid. From this we learn that the organs of respiration are endowed with a capability far beyond the normal requirements, the volume of air being increased eight-fold, that of carbonic acid nearly six-fold. Had Vierordt been able to continue these laboured respirations without damage to his organs, he must necessarily have consumed more food for the increase of carbonic acid, or otherwise have expended his own substance.

At page 381, vol. iii., Lehmann recites experiments carefully conducted by Hanover on patients suffering from pulmonary disease, which shows that the absolute amount of carbonic acid increases with the number of respirations, whilst the relative amount (that which is contained in a given volume of air) diminishes. These experiments tend to confirm in a remarkable manner my suspicions as to a greater consumption of carbon during this disease; they show also that the organs of respiration, though weakened, inhale a greater quantity of air, and

exhale also an increased quantity, though less in proportion, of carbonic acid. From the diminished proportion of the carbonic acid to the volume of air in the increased respirations, it is clear that the system could not afford an adequate supply of carbon.

When in London I sought an interview with Dr. Theophilus Thompson, F.R.S., with the object of learning his views on the efficacy of oil as medicine, of which he has had great experience, and which, I am informed, he first introduced into the London hospitals. In the course of conversation he drew my attention to several cases, in which his patients had gained more by the use of cod liver oil than the weight of the oil supplied. I ventured to suggest that this might possibly be attributed to the food being deficient in elements which are found concentrated in oil; in support of which I explained that in my treatment of dairy cows I have completely satisfied myself that by adding to ordinary food beans or other materials peculiarly rich in albumen but comparatively deficient in oil, I enrich the milk not only in curd but also in butter, to a far greater extent than is contained in the oil of such additional food.

Lehmann (Leipsic), second edition, page 271, states: "On theoretic grounds I have long been satisfied that fats belong to the most active agents in the metamorphosis of animal materials (of digestion), and that by numerous experiments and observations I have completely assured myself of this (*that what had been matter of subjective, had by experiment become matter of objective certainty*)."

These experiments he explains, and cites others by Elsässer, which show that the digestion is materially assisted by an admixture of fat. I learnt from Dr. Thompson that cod liver oil is composed almost wholly of carbon and hydrogen, with a smaller per-centage of oxygen than other fats. I did not ascertain from him, nor do I find in his lecture to the Medical Society, a copy of which he kindly presented to me, the relative proportion of oleine and margarine fats. In Royle's 'Materia Medica' there is a proximate analysis of this oil by Dr. de Jongh, which gives—

Of oleic acid	74·
Margaric acid	11·75
Glycerine	10·17
Butyric and acetic acid	·11
Other substances	3·97
	100·

This analysis shows a far greater per-centage of oleine compared with margarine than any other fat I have seen noticed.

That the nutritive effects of materials for food depend much on their proximate elements I need only adduce the composition of the grain and straw of wheat, which are very similar in their proportion of ultimate elements, whilst the predominating proximate principle of the grain is starch (73 per cent.), that of straw woody fibre, of which it contains 61 per cent. with only 36 of starch. That oleine is more easy of consumption (more available for respiration), I refer to Lehmann, vol. i., p. 121, where he states that the fat of animals being found to contain a greater proportion in comparison with the fat of plants, may probably be attributable to the oleine being more easy of consumption.

My attention was drawn to some experiments of Dr. Leared, published in the 'Medical Times,' from which it appeared that the oleine of cod liver oil agreed better with several of his patients than the oil in its natural state, from which he drew the inference that the effect of margarine was excrementitious; this can only apply to patients whose organs are weakened. My observations on feeding tend to the conclusion that if you afford animals an adequate supply of sugar, starch, and olein fats for their respiratory and other functions, the margarine of the food will be converted into and stored up in animal fat to the extent which the system is capable of absorbing. I am, however, clearly of opinion that on a deficiency of food or incapacity of the organs from disease or other causes to supply the wants of respiration, the stores of solid or margarine fat are laid hold of and consumed. In the spring of 1853 I sold some fatted cattle to Mr. Freeman, of Otley, with whom I had frequently dealt; he reported that they did not contain the quantity of loose fat which he had been led to expect from their touch and his experience of my feeding. Having told him that they had recently suffered from soreness of mouth, by which with evident symptoms of appetite they were hindered from eating the necessary quantity, Mr. Freeman remarked that he well knew from experience that cattle which had recently suffered from this (known here as the mouth and foot sore complaint), were deficient in loose fat. I may also here state, as a matter of some physiological interest, that cattle which have been partially damaged in the lung from previous attack of pleuro or other causes are invariably found deficient in their store of loose fat.

It will be observed that cod liver oil contains in the same space the greatest proportion of elements which, in combination with the oxygen of the air, are necessary for the support of vitality, and with this by far the greatest proportion of olein in comparison with other oils in their natural state; and it seems

worthy of remark that this oil is held in the greatest esteem for pulmonary complaints; next to this, and almost in equal repute, is pure olein.

From what has been premised it will be found that from consideration of the symptoms of pleuro-pneumonia I was led to suppose an abnormal consumption of the elements which support respiration. I have sought to meet this by a supply of food particularly rich in such elements, and in a form most available for their purpose. My observations on the effects tend to confirm my opinion that by this means I supply in food what would otherwise be abstracted from the system with greater labour to the organ and with impoverishment, thereby weakening the ability to resist disease. I am therefore encouraged to offer it for the consideration of those who give their attention to pathological chemistry.

If any owners of cattle should adopt my treatment I urge the most scrupulous attention to the treatment here prescribed for the sick animal. I am clearly of opinion that one of the animals which died might, by a greater observance of this, have been restored.

In the course of the foregoing observations I have made frequent allusion to Lehmann's 'Physiological Chemistry.' About a year since I obtained this work on loan for a short time from a member of the Pharmaceutical Society. A perusal of such portions as seemed likely to afford me the particular information I was then in quest of, disclosed to me the pen of an author, master of his subject, and of great research and acquirements. With some difficulty and through the kind assistance of others I have recently obtained the whole work, three volumes, the first and second in German, the third in English. I learn that in both languages it is out of print. I cannot but hope that ere long another edition of a work, every page of which is replete with information of peculiar interest, will be published.

Burley Hall, May, 1858.

IX.—*Report on Steppe Murrain or Rinderpest.* By James Beart Simonds, Professor of Cattle Pathology in the Royal Veterinary College.

Epizootic diseases, and particularly those that have prevailed among cattle and sheep, have in all ages excited much attention and taxed the pen of the faithful historian, as well as the cultivator of the science of medicine, to record their successive outbreaks and devastating effects. It is not, however, our intention in this report to follow in a succinct manner the account which has been given of these diseases, extending, as it does, from the period of the infliction of "a grievous murrain" of "boils and blains" on the cattle of Egypt, as a Divine punishment to the obdurate Pharaoh down to our own times, but to record the result of our investigations into the nature and consequences of the disease which recently seemed to threaten to invade our shores. Whether "the murrain" that fell upon the cattle of the Egyptians has been permitted, in an altered or mitigated form, to remain as a scourge to succeeding nations, is a problem which cannot, we opine, be satisfactorily solved by any supposed resemblance which our present cattle-plagues may bear to the one described by the Sacred historian. This fearful and miraculous visitation must be regarded as the chief of these scourges, however destructive they may since have been. In the times of the ancient Greeks and Romans these outbreaks were not unfrequent, and numerous records of them are left by Homer, Plutarch, Virgil, and others. Columella, at about the commencement of the Christian era, speaks of them as contagious diseases; and Vegetius, in the fourth century, treats largely of their contagious properties, and recommends that the diseased animals should, "with all diligence and care, be separated from the herd, and put apart by themselves." Fracastorius and Weierus also describe the sad effects of one of these visitations in 810, when it is said that the greater part of the cattle perished throughout the Emperor Charlemagne's dominions.

The first recorded instance, however, which we find of the cattle in England being affected by one of this class of diseases, is in 1713-14, at which period an epizootic, that for a few years previously had prevailed in several Continental states, suddenly broke out here, and swept off many of our cattle. No account sufficiently explicit upon the nature and progress of the disease has been handed down to us, so that it is difficult to speak with certainty of its true characters, and much more either of its duration or the amount of loss which the country sustained. It appears, however, that the malady possessed many of the features of *Eczema epizootica*, now common in this country, and it may possibly have been identical with this disease. The infection

seems to have been communicated by the saliva, as it is said that "when this is dropped on the grass, and sound animals are immediately placed on the same pasture, they contract the disorder, and, in some bullocks, the tongue was inflamed and covered with many red blisters."

This malady was succeeded, in 1744, by one of far greater importance, because attended with a far greater fatality. The disease in question early attracted the attention of the Government, who promptly adopted vigorous means of arresting its progress. It is asserted that the malady first appeared in the neighbourhood of London, whence it extended over the length and breadth of the land, destroying hundreds of thousands of cattle, and continuing its devastating effects with almost unmitigated severity down to 1754-5. Its introduction here has been differently accounted for; but it is pretty generally attributed to the importation, by a farmer residing at Poplar, with a view of improving his breed, of two calves from Holland, in whose systems the disease was incubated. Dr. Layard, in his Essay on the disease, says, however, that an opinion prevailed that it was brought over by an English tanner, who had purchased "a parcel of distempered hides in Zealand very cheap, because they were forbidden to be sold there, and should have been buried." It seems, therefore, to have been confidently believed at the time that the disease was an imported one,—a circumstance of great practical importance now that we are receiving several hundreds of cattle week by week from the Continent; although, as this Report will hereafter show, our own investigations have proved that no fear need be entertained at present of "the great cattle-murrain" visiting our shores. Notwithstanding the deep and painful interest which this disease excited, and the efforts made by the Government of the day to stay its ravages, no correct estimate can be formed of the numbers of cattle which were lost to the country from its duration and extension; but it was ascertained by one of the commissioners appointed by the Government that in Nottinghamshire alone 40,000 head of cattle perished in six months, and in Cheshire upwards of 30,000 in the same space of time.

By a special Act of Parliament, the King in Council was empowered to issue such orders as were deemed the most effective to arrest the progress of the pest. Instructions were thereupon given—

1st. For the killing of all the infected animals, and burying them entire with the skins on, "slashed from head to tail," that they might not be used for the purpose of the manufacturer.

2nd. For the burning of all the hay and straw used about the animals.

3rd. For the cleaning and fumigating the sheds, &c., and for no sound cattle to be put in them for two months after the removal of the diseased.

4th. For no recovered animal to be allowed to go near others for a month after its convalescence.

5th. For no diseased cattle to be driven to fairs or markets, nor for the flesh to be used as food for dogs, &c.

6th. For no *healthy* cattle to be removed from a farm where the disease had prevailed in less than a month after its disappearance.

And, lastly, orders were given for the notice of an outbreak to be immediately sent by the farmers to either the constables, churchwardens, overseers, or the special inspectors appointed by the magistrates acting for the parish or district. The Government also undertook to pay forty shillings for every ox, bull, or cow which was killed, and ten shillings for every calf, with a corresponding price for their skins.

Mr. Youatt, in his account of the disease, as published in the work entitled 'Cattle,' says, "Of the propriety of this bonus for the destruction of infected cattle, there cannot be a doubt, for there were numerous instances in which those who began to kill the sick as soon as the distemper appeared among their cattle, lost very few; but others, who would kill none until their own folly had made them wiser, did not save more than one out of ten."

Many difficulties were thrown in the way of carrying out the instructions, and not a few impositions were practised by some designing persons claiming the award for old and worn-out animals, as well as for those which were suffering from totally different diseases. In this day, now that veterinary surgeons are practising in every part of the country, such frauds would scarcely be attempted; and we believe, in the event of occasion requiring it, that a system of inspection, comparatively inexpensive, might be devised which would effectually prevent any instances of the kind.

It is further recorded that in one year, the third of the existence of the disease, 135,000*l.* was paid out of the Treasury as a recompense for the cattle killed according to the prescribed orders, and that during the same year 80,000 head of cattle were killed, and nearly double that number died from the disease. To meet this alarming state of things, and the difficulties which sprung out of the adoption of the measures of the Government, various other Orders of Council were promulgated, and in the *third* order we find that *no* cattle, fat or lean, would be suffered to pass the Humber and the Trent northward from its date, namely, January 19th, 1747, to the 27th of the following March; the object evidently being to protect the cattle in the northern

P 2

counties by cutting off all direct communication between them and the infected districts for two months.

Newby, in an Appendix to his work on mangel wurzel, states that the cattle-fair at Barnet had its origin in the existence of this disease. "The fair," he says, "was formerly kept at Islington, till the distemper which raged violently among the cows at that place in 1746 obliged the Welshmen to remove to Barnet, where it has been continued ever since."

Great as were the losses, no reasonable doubt can be entertained that they would have been much augmented had not the Government taken the course it did, and it is also probable that the continuance of the disease would have been extended over a far greater number of years than it was. The attempts at cure were not satisfactory, and very little was known of the true nature of the malady even by those members of the medical profession who gave attention to it, for there were then no properly educated veterinary practitioners. After a careful perusal and analysation of the writings of the different physicians who have treated of the affection, we believe that we are justified in saying that it was identical with the disease that has recently excited so much fear and alarm in the public mind, as being likely to be introduced from the continent.

In 1754-5 this cattle pest declined in amount and virulence, and took its final departure a few years afterwards. From this period England appears to have been singularly exempt from epizootic diseases, and to have remained so down to August, 1839, when great anxiety was created by the sudden and almost simultaneous appearance of a "new affection" (although probably of the same nature as that of 1713-14) among the cattle in different parts of the country. The earliest accounts which we received of the outbreak came from Norfolk, and there seems no reason to doubt that it was here that the malady was first observed. Cattle of all ages and under every variety of system of feeding and management became the subjects of the disease, which was recognised by the existence of vesicles upon the upper surface of the tongue, inside the lips, and the dental pad. Vesicles were also formed between the digits, and occasionally upon the teats and udders of the cows. The existence of these vesicles was associated with a discharge of viscid saliva from the mouth, loathing of food, imperfect mastication, suspension of rumination, loss of milk, a tenderness in walking, and general symptoms of febrile action.

The malady was not confined to cattle, but sheep, pigs, and domestic poultry of the gallinaceous tribe were likewise its subjects. By common consent it was designated the cattle epidemic, but has since been scientifically known as *Eczema epizootica*, or

popularly as "the mouth and foot disease." It has continued from that time to the present, not proving on the whole a destructive disease to life, but at irregular intervals assuming a more severe form than ordinary, more particularly in 1845 and 1852, and leading on these occasions to a great deterioration in the value of the animals affected.

Shortly after the appearance of eczema, namely, in 1841, pleuro-pneumonia broke out among the cattle, and it, too, has remained down to the present time. It is worthy of a passing remark that neither of these were imported diseases. It was not until several months after pleuro-pneumonia had established itself in the country that an alteration took place in the tariff by which live stock came in free of duty, and up to that time the high rate of duty prevented any importations of foreign cattle or sheep being made. This fact in itself is sufficient to prove that the malady was not imported by foreign cattle; besides which the parts of the country where it was first observed could not possibly have had any immediate or direct connexion with the ports. Pleuro-pneumonia had no sooner gained a footing, than, following the laws of all epizootics, it quickly spread over a great extent of country, and continued to devastate our herds with almost unmitigated severity for the first few years. It has since assumed rather an enzootic form, and has prevailed mostly in those localities and places where secondary causes are in full operation to predispose animals to its influence,—hence its continuance in the ill-ventilated, over-crowded, and badly-drained cow-sheds of the metropolis and other large towns, and on the "cold retentive soils" and undrained farms in the country, especially such as lie in exposed situations.

Besides the special cause, or rather, perhaps, special combination of causes, which give origin to the enzootic form of pleuro-pneumonia, its appearance in a cattle-shed or on a farm is frequently traceable to the introduction of newly-purchased animals, who bring the disease in a latent state with them; and which, on its declaring itself, extends by ordinary infection to those with whom they are located. Infection we hold to be one of the chief causes of the continuance of pleuro-pneumonia for so many years among us, as every diseased animal by virtue of the exhalations given off from its body becomes a focus of the malady, and a new source whence the poison, so to speak, is disseminated.* The same fatality which marks the

* It is with considerable hesitation that I record my dissent from the opinion of so high an authority as Professor Simonds, but the question whether pleuro-pneumonia be infectious or not, is so important, that I think it right to mention that the experience of several successive years, and of a considerable number of cases, makes it impossible for me to subscribe to the opinion that this disease is

progress of pleuro-pneumonia here, attends it everywhere; and throughout the continent it is looked upon as an incurable disease, and dealt with accordingly. Its great fatality arises from the circumstance that the nature of the changes which take place in the lungs is such as immediately to arrest their function as perfect aerifying organs, and soon to destroy to a greater or less extent the integrity of their structure. The true pathology of pleuro-pneumonia is one of the *quæstiones vexatæ* of science. In this Report we have not immediately to do with this question, still we may observe that the most eminent professors of veterinary medicine throughout Europe hesitate to declare, as some medical men have done, that the changes wrought in the lungs are altogether due to inflammatory action.

In Belgium, in France, and in many parts of Italy, the disease is designated *exudative* pleuro-pneumonia—a name which, while it marks a peculiarity in the disease, implies, at the same time, that it differs somewhat in its results from ordinary inflammation of the lungs and their investing membrane, and which is correctly called pleuro-pneumonia. We have no hesitation in giving it as our opinion that the changes which are *originally* effected in the lung tissue can take place otherwise than by inflammatory action. We observe, as the analogue of these changes, that in the advancement of the disease, the interstitial areolar tissue, contiguous to the more affected parts of the organs, is primarily choked with *serous* effusion, which, by its pressure upon the air-cells and their rete of capillary vessels, obstructs both the admission of air to the cells and the circulation of the blood through the vessels, and thus leads to an imperfect decarbonisation of the blood, as well as to far more important changes in the fluid itself. Not only, in many diseases, are serous exudations often and entirely independent of inflammation, but fibrinous are equally so in the opinion of some of the ablest pathologists of the present day. These deposits may result from the vital force of the vessels being impaired by some depressive influence acting on the nervous system, either generally or locally, as well as by some unexplained or ill-understood alteration taking place in the composition of the blood, by the existence within it of morbific animal or vegetable products. The fibrinous depositions in

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either infectious or incurable. For several seasons prior to 1857 I had a few cases annually amongst my cattle, of which some died and others recovered. The diseased animals were not separated from their companions unless likely to die, and then not until the last stages of the complaint, yet the disease never spread, nor was any large proportion of the herd attacked, and I could generally trace the outbreak to the prevalence of cold fogs or to rapid alternations of temperature, especially if occurring in spring or autumn. With reference to the possibility and mode of cure, see Mr. Horsfall's paper in the present volume, p. 189.—H. S. Thompson.

pleuro-pneumonia succeed the serous, and are probably due to either an alteration in the relative proportion of the component parts of the blood, or an interference with its vitality, brought about by the presence of the special *materies morbi* of the disease, and which may have entered it in the ordinary manner of infection. The abnormal action which commenced in the parenchyma of the lungs extends towards their investing membrane, when, from the nature of this tissue, as well as from the longer existence of the action itself, an augmented fibrinous exudation takes place upon their surface. We regard, therefore, the implication of the pleura as a characteristic of an advanced stage of the malady, and also of a still further deterioration of the blood.

Since the appearance of pleuro-pneumonia no other disease of a fatal character and possessing contagious or epizootic properties has shown itself among our cattle; but in 1847 a very fatal malady broke out among sheep. This affection was recognised as the small-pox of sheep; and it was ascertained in the most conclusive manner that it had been introduced here by some "Merinos" which had been shipped at Tönning on the coast of Denmark, and also by some others shipped at about the same time at Hamburg for the supply of the English market, and in whose systems the disease was incubated. From the free commingling of these foreign sheep with our own breeds in the London Cattle Market, and also from the circumstance that many of them were purchased by farmers as "stock sheep," the small-pox was soon spread over a great extent of country, proving destructive to life in numerous instances at the rate of even 90 per cent.

This state of things was met by legislative enactments with a view to arrest the progress of the disease, and happily they proved of essential service in so doing. By the expiration of the third year from the outbreak, scarcely an instance of the disease could be met with in any part of the country, and this notwithstanding that tens of thousands of animals were, to our own knowledge, affected in the year succeeding its introduction. From the time of its subsidence in 1850 until now we have been perfectly exempt from cases of small-pox.

This short historical account of epizootic affections of cattle in this country brings us down to the present period, and to the especial subject of this Report. It was during the latter part of the past year that the public mind became much excited by frequent and almost continuous reports that a malady of a most fatal description had shown itself among the cattle on the Continent, and that it was rapidly extending towards those countries whence we received our chief importations. In the early part of the present year the subject assumed so much practical importance that the attention of Parliament

was directed to it on two or three different occasions. Her Majesty's Government early gave instructions for our Consuls abroad to collect all the information they possibly could in their several localities, and transmit the particulars of their inquiries without delay to the Minister of Foreign Affairs. These despatches were from time to time forwarded by LORD CLARENDON to the Council of the Royal Agricultural Society, who also had from the beginning taken the liveliest interest in the matter, and who lost no opportunity of placing the latest information before the country through the weekly publication of their proceedings.

These official documents in no way tended to allay public apprehensions, but rather, on the contrary, to increase them, as it was distinctly stated that the "murrain" was rapidly making its way westward from the countries where it had been first observed, and that it would ere long be introduced here unless the greatest caution was exercised in regulating our supply of foreign cattle, and even then it was more than probable that the disease would come in, as it was said that it could be carried from place to place by skins, hoofs, or horns, or indeed anything which had been exposed to the infection by being brought near to the diseased animals.

Notwithstanding the great amount of information supplied by our Consuls, very little of a satisfactory kind could be obtained with reference to the true pathology of the disease. The Council of the Royal Agricultural Society therefore felt that under such circumstances as these some more decisive step should be taken, and at this juncture a communication from the Royal Agricultural Improvement Society of Ireland was received, suggesting "that it would be desirable for the three Agricultural Societies of the United Kingdom to join in the common object of despatching abroad a special veterinary inspector, for the purpose of ascertaining the exact nature of the 'contagious typhus.'"

At a meeting of the Council, held on the 1st of April, some further communications were read from Mr. Hall Maxwell, C.B., Secretary of the Highland and Agricultural Society of Scotland, and from Captain Croker, Secretary of the Royal Agricultural Improvement Society of Ireland, expressing their willingness to concur with the Royal Agricultural Society in arrangements for despatching a Veterinary Inspector to the districts abroad where the cattle murrain is at present raging. The Council therefore came to the following resolution:—

"That it is expedient to send a competent veterinary professor to examine into the nature of the cattle murrain on the Continent. That the Society gladly accepts the co-operation of the Highland and Agricultural Society of Scotland and the Royal Agricultural Improvement Society of Ireland in this

step. The Society ventures to recommend that Professor Simonds, of the Royal Veterinary College, be commissioned to this task. That he be empowered to take with him a German veterinary surgeon, established in London, quite competent for the business, and who would smooth the difficulties of the German language. It is supposed that about three weeks would be required for a satisfactory examination. That the Highland and Agricultural Society of Scotland be informed that the Royal Agricultural Improvement Society of Ireland propose to share the expense of this mission with the Royal Agricultural Society of England; and that they be asked to join in the same manner."

The National Societies of Scotland and Ireland readily consented to the proposition contained in this resolution; and on the Government being informed of the step about to be taken, Lord Clarendon kindly forwarded a letter of introduction to the British Consuls to the Secretary of the Society, accompanied by the following communication:—

"Foreign Office, April 4, 1857.

"SIR,—I am directed by the Earl of Clarendon to acknowledge the receipt of your letter of the 2nd instant, acquainting his Lordship with the intention of the Council of the Royal Agricultural Society of England, in conjunction with the Societies of Scotland and Ireland, to send Professor Simonds to those districts abroad where the disease among cattle is at present raging; and I am to enclose a letter which has been addressed, by Lord Clarendon's direction, to the British consular agents in Northern and Central Europe, instructing them to afford to Professor Simonds all the assistance in their power in carrying out the objects of his mission. "I am, Sir,

"Your most obedient, humble Servant,

"*James Hudson, Esq.*" "E. HAMMOND.

The first step, according to my instructions, being to secure the services of a veterinary surgeon familiar with the German language, I at once called on Mr. Wm. Ernes, M.R.C.V.S., a gentleman eminently fitted for the task; and who, besides being a native of Belgium, had had the great advantage of travelling almost throughout Europe, thus becoming practically acquainted with most of the foreign languages. Mr. Ernes had also received an English medical education, and his tastes were in full accordance with the objects of the mission. Having secured his co-operation, we left London for Belgium on the morning of April 9th, and arrived the same evening at Ghent. We deemed it expedient to ascertain, with as little delay as possible, the health of the cattle in those countries whence we were receiving our daily supplies, and also the details of the system which prevailed with regard to the cattle-trade, together with the particulars relating to the shipment of animals to England. This part of our mission was the more pressing as the recent Order in Council prohibiting the importation into the United Kingdom of "cattle or of horns, hoofs, or hides, from those territories of Russia, Prussia, or Mecklenburgh-Schwerin, which lie in the Gulf of

Finland, or between the Gulf and the city of Lübeck," might be found to require an immediate extension to other countries, or possibly we might ascertain that a relaxation of it could be made without the incurrence of a greater risk of the disease being introduced. We therefore commenced our inquiries in

Belgium.

Our investigations here fully confirmed the statement made by Lord Howard de Walden, her Majesty's Ambassador at Brussels, in his despatch to Lord Clarendon, dated March 20th, 1857, that this country was perfectly free from the Rinderpest. We found that eczema epizootica prevailed to some extent, but not in a serious form, and that pleuro-pneumonia also existed in several parts of the kingdom. Rinderpest had not shown itself to an extent to create much solicitude since the Seven Years' War, during which time it destroyed vast numbers of cattle. From 1813 to 1815 some cases occurred in the district between Namur and Luxemberg, which are said to have arisen from the passage of the Austrian army into France. The route taken by the army was south of the Belgian frontier, and near to the places in question; and it appears that along its whole course the disease was manifested to a greater or less extent on either side of the military road. It is also said that the cattle belonging to the Prussian army being healthy, no disease followed its course through the country, and thus a great part of Belgium escaped the pest; the measures of sanitary police confining it chiefly to the neighbourhood of Namur, and the districts in which it had manifested itself. We refrain from commenting on these facts in this place, as hereafter we shall have to call attention to the freedom of Continental states in general from the disease, unless infected cattle, or such as have been exposed to the contagious influence of the malady, are introduced therein.

At Ghent we visited a cattle fair which was held the day after our arrival, and had thus an opportunity of observing the general state and condition of animals brought from all parts of the kingdom, which proved to be most satisfactory. From the cattle-dealers we learned that no difficulties are put in the way of the passage of cattle to or fro over the *frontier*, so long as they are healthy, but that restrictions would be rigidly enforced on the breaking out of a contagious disease. Lord Howard de Walden writes that "no law exists under which diseased cattle can be excluded at the *frontier;* a project of law, with a view to such sanitary precaution, was presented to the Chambers two years ago, but was rejected; and therefore the only resource lies in the activity of the Burgomasters in frontier localities, by enforcing the general regulations in regard to animals while within the

range of their jurisdiction." Pleuro-pneumonia has prevailed rather in a sporadic than an epizootic form for the last two years; and an equal number of cases are said to have occurred in places where the feeding and general management of the animals are unexceptionable, as in those where the opposite state of things obtains, but that, under the latter named circumstances, the disease has assumed a more fatal character. All animals which are supposed to be affected by this disease have to be reported by the proprietors, and if, on examination by the governmental veterinary-surgeon, they are found to be the subjects of it, an order is given for them to be killed. The skin, horns, and other integumental parts are used, but the flesh is buried as a rule, in accordance with the regulation of the Government, who pay a proportionate amount of the value of the animal, generally to the extent of one-third. It appears, however, that this regulation is sometimes evaded, and that the carcases of such animals occasionally find their way into the meat-market; but no instance of injury done to persons eating such flesh is known to have occurred. Many animals also are not officially reported, as the proprietor either sells them for slaughtering or has them killed unknown to the authorities. Should this, however, become known, the animal is seized and disposed of as the Government sees fit, and a fine is also inflicted on the offender. Upon the whole, the laws of the sanitary police are so strictly enforced, that, in the event of the rinderpest extending into Belgium, it seems scarcely possible for animals which had *even been exposed* to its infection to be exported from the country.

At Antwerp, we ascertained that the chief exports of animals to England from thence are calves, and that the major part of the cows and oxen which are fatted for the market are sent into France, where at this time a better price is obtained for them than in England. The calves are purchased of the farmers in different parts of Belgium by commissioned agents, who collect them together for shipment from Antwerp, but some of the oxen come direct from Holland. The proportionate amount of oxen to calves which are exported, is shown by a Return furnished by MM. Vandenbergh for the year 1856. The MM. Vandenbergh are the largest shippers of cattle to England, and although a few animals are sent over by other companies, they are in about the same proportion. The Return shows that 2020 calves were forwarded here within the year, but only 10 oxen.

Holland.

As this country sends our principal supply of foreign cattle and sheep, it became the more important to ascertain their

freedom or otherwise from contagious diseases. With the exception of pleuro-pneumonia and eczema, no other affection prevails among the cattle. Rinderpest has had no existence for upwards of forty years, and is unknown even to the veterinary profession except by name. The parts of the country most affected with pleuro-pneumonia at this time are North Holland and Friesland. By a statistical return from forty-three villages in North Holland and Friesland it is shown that only eight of them have been comparatively free from pleuro-pneumonia, and in those but very few cattle are kept. In the villages where the disease has prevailed, about a fifth part only of the cattle-owners have escaped upon the whole, but in many every proprietor has had his herd affected. In the first quarter of the present year the official returns show a total loss of 3655 head of cattle, of which 1502 died and 2153 were killed by order of the authorities, which gives an average loss of about 281 per week. We are not surprised at the great extent of these losses, judging from what we saw of the secondary causes of epizooties in operation in the vicinity of Rotterdam. The cattle are often crowded into houses so thickly that to pass between them is almost an impossibility, while the form and size of the building will frequently allow of a passage only to be made by a person along its centre, where the heads of the animals nearly meet over their feeding-troughs, the height being likewise insufficient to stand upright in. No windows exist in many of these sheds, nor any other inlet for light and air except the door. The heat is almost suffocating, and the stench abominable. In such unwholesome and pest-breeding places as these, the cattle, often to the extent of forty to fifty in a shed, are kept for weeks together to be fatted for the market, by being fed chiefly on the wash and grains which come from the distilleries.

The cattle which are sent from Friesland are shipped at Haarlingen direct for England, and the numbers put on board there are fully six times greater than at Amsterdam. Friesland is one of the great cattle-districts of Holland, and supplies not only the English market with many animals, but other countries likewise. She therefore receives no imports, nor does it appear that any of the vessels conveying cattle from the ports of the Elbe, or the Weser, or from any part of the coast of Holstein, ever touch at the Dutch ports, so that a contagious malady like Rinderpest, existing in Holstein or in the countries watered by those rivers, would have to make its way by land into Holland.

No restrictions are put upon the cattle-trade with reference to the bringing of animals over the frontier, but all importations of the kind would be immediately prohibited on the appearance of the disease in question in any neighbouring states. The prices obtained for cattle in the English market are not viewed as being

sufficiently remunerative just now by the Dutch feeders, and hence the diminished numbers sent here. When the contrary state of things prevailed, many animals were purchased in Prussia by the dealers and forwarded to the different ports of Holland for exportation, and not a few, it is said, came even from Switzerland down the Rhine for the same purpose. These facts show that it is possible for a disease of a malignant kind, which is incubated in the system of an animal for ten days or a fortnight, to be introduced into England from other countries *viâ* Holland. The continuance of a well-ordered and rigid system of inspection of imported animals on our part will, however, do much to protect us, and that not merely by its leading to the detection of diseased animals on their arrival, but by the effect which it will have upon the export trade of foreign countries. Proof of this is given by the circumstance that last year, when it became known that our Customs inspectors had received orders to be particularly strict in the examinations of cattle, the General Steam Navigation Company of Rotterdam, unwilling to take the responsibility of the probable rejection of animals committed to their care, appointed a veterinary surgeon to examine them when put on board their boats. This company brings by far the largest proportion of cattle to England, and although this precautionary measure was not adopted by other shipping companies, they nevertheless declared their intention of having recourse to it, and only refrained from so doing, because of the great diminution which took place in the number of the animals which were shipped. The system of examination was kept in force for about three months, when from the same cause the General Steam Navigation Company also discontinued it. The returns of these examinations, together with the results, were regularly transmitted to the British consul. Should the prices again rise in England to an extent which would, in the opinion of the cattle-feeders, justify them in sending us more animals, then there cannot be a doubt of the re-establishment of this system of inspection.

No duty is chargeable on animals imported into Holland, but an *export* one has to be paid, which amounts in English money to about the following rate per head, namely, oxen, 10*d.*, calves 2*d.*, sheep 2*d.*, lambs 1*d.*, and pigs 1*d.*, with an additional duty of thirteen *per cent.* on the gross sum.

Although Holland rears immense numbers of cattle, she, from her great export trade in these animals, becomes an importing country for hides, receiving her chief supply of these from Java and Buenos Ayres, with some from England, but none from Russia, so that all fear of our introduction of contagious diseases through the means of skins may cease, in so far as Holland is concerned.

Our investigations led us to visit the cattle-feeders, and among others we saw Mynheer A. Poot, who resides within a few miles of Rotterdam. M. Poot ships upon an average 600 animals a year. He informed us that no disease had prevailed in his sheds since February last, prior to which time he had several cases of pleuro-pneumonia. He appeared to be an entire stranger to any other contagious disease, and said that, in the event of an affection like Rinderpest breaking out among his stock, a *cordon* would be immediately placed around the farm by the *local* authorities, and that he should be compelled to slaughter the diseased animals and bury them with their skins on in quick lime. In his opinion it would be an impossibility to export any portion of their carcases to England, even if attempts were made to do so, in consequence of the strictness with which the police sanitary regulations are carried out. He adduced as an instance that on the first breaking out of pleuro-pneumonia in 1829, and before experience had shown that the flesh could be safely used for food, he and others had to kill the affected cattle and bury them entire, with a view to prevent injury being done to the people, as well as to limit the spread of the malady. On the question of our government ordering all imported animals to be slaughtered on their arrival in the docks, and their carcases sent to the meat market, M. Poot considered that such a step would be tantamount to stopping of the importations entirely. The boats very rarely, if indeed at any time, are freighted with cattle all belonging to the same person; the cargo therefore is mostly comprised of animals the property of several individuals, and identity of each particular animal, which is necessary for the purposes of trade, could scarcely be made under such circumstances; besides, he said, a necessity would be created for an immediate sale of the meat to the injury of the interests of the persons sending the animals. He was equally opposed to the establishment of a quarantine, and was of opinion that it could never be carried into practice, and England continue to receive full supplies of foreign cattle.

The system at present adopted is for various feeders to consign their cattle to salesmen in the London market, who, as in the home trade, charge a commission on the sales they effect. As no animals are brought into Rotterdam coastways for reshipment, all consequently have to pass through the town to reach the vessels, so that they are thus subjected to the general inspection of the local authorities, regulations existing to prevent diseased animals from entering into this and the other towns of Holland. Besides the security thus afforded it is clearly not in accordance with the interests of the exporters to put diseased cattle on board, as it is impossible for them to bear up against

the fatigue of a sea voyage, or to be on their arrival here in a fit state to pass the scrutiny of our Customs inspectors.

The cattle which are fatted either for the Dutch markets or for exportation are purchased at the different fairs and markets in the country, and are for the most part reared in Friesland and Guelderland, scarcely any being brought in from other countries. Upon the whole, notwithstanding the dangers we have pointed out, the system which prevails generally with regard to the cattle trade, and the additional regulations which would be enforced did necessity arise, appear to offer a fair amount of security against the introduction of a new cattle pest from Holland.

Westphalia and Hanover.

These countries are entirely free from Rinderpest, and have been so for upwards of forty years; besides which, very little disease of any kind was found to be prevalent among the cattle. The laws which are enforced with regard to contagious diseases are analogous to those which are generally adopted upon the Continent, but differ a little in some of their details.

Pleuro-pneumonia was said by the late M. Hausmann, Professor of the Veterinary School, to have been first observed in Hanover as early as 1807. The disease has existed with some few intervals, and with more or less severity, down to the present day. Of late years the animals attacked have been so few as not to create any great solicitude on the part of the government. Precautionary measures are, however, adopted on the frontier with regard to cattle coming from Holland, which are made to undergo a quarantine, and none are allowed to enter from Holstein, unless they are certified to be in a state of perfect health. Veterinary surgeons are bound to give notice of all cases of contagious disease which they may meet with in their practice, and proprietors also are required to report the appearance of pleuro-pneumonia or allied affections among their cattle. No animal, although seemingly in perfect health, if it has been living with others affected with pleuro-pneumonia, can be pastured or driven on roads so as to come within two hundred yards of other cattle; nor can the owner dispose of any of his herd, under such circumstances, until it is certified by the veterinary surgeon of the department that all the animals are perfectly free from the disease. The period of time which is allowed to elapse after the passing away of the malady, and the power of selling the cattle, is left to the discretion of the veterinary surgeon. A proprietor can place his animals under medical treatment if he sees fit, or he is at liberty to slaughter them and send them to the meat-market. The flesh of those affected with pleuro-pneumonia, even in its advanced stages,

is not unfrequently sold, as in England, by the inferior class of butchers.

A regulation exists with regard to the disease glanders, which, although it does not belong to the special object of this report, may, nevertheless, be mentioned. Horses affected with this disease are not only prevented from being sold or exposed for sale, but the owner is compelled to have them killed; and he is not allowed, under the pain of a heavy penalty, to sell any other horse out of his establishment, or even to place any one of them in stables belonging to other persons, for six months after the death of the affected animal.

M. Hausmann, Veterinary Surgeon to his Majesty the King of Hanover, informed us that a conviction had very recently taken place under this law, where a carrier was heavily fined for putting his horses, which had been with a glandered animal, into a stable at a public inn in the town of Hanover on the occasion of his coming there on the market-day.

Hamburg.

This as the chief port of the Elbe receives a considerable number of cattle from the surrounding districts for exportation to England, and large quantities of hides are also exported from hence. Some diminution has taken place in the amount of cattle which has been shipped at Hamburg of late, and from the same cause which is assigned by the exporters from Holland, namely, that the price obtained in the English markets is not sufficiently remunerative when compared with that which can be procured at home. The cattle come chiefly from the distillers, sugar-refiners, and farmers in the town and territory of Hamburg and the adjoining duchies of Holstein and Lauenburg. They are usually sent first to the market at Hamburg, and if not sold are exported to England. An inspection of them is regularly made in the market by a duly appointed veterinary surgeon; besides which they are prevented entering the town unless found to be in a healthy state. These regulations afford us a certain amount of security against the importation of diseased animals from the port of Hamburg. This system of inspection has been in operation from the commencement of the recent outbreak of pleuropneumonia in Holstein, and has been particularly observed since September, 1856, when the following proclamation was made by the Senator of the Marshlands of the territory of Hamburg:—

Proclamation.

It having been communicated to the Senator for the district of the Marshlands that in several parts of the duchy of Holstein a pulmonary disease has

again broken out among the cattle; in order to prevent the introduction of this dangerous malady, it is hereby ordered that for the present no cattle can be brought into the district of the Marshlands from the duchies of Holstein and Lauenburg without a certificate from the proper local authorities, stating that, at the places from whence the cattle may come, no infectious disease prevails among the cattle, and this under a penalty of 50 thalers for every case of contravention.

The whole of the bailiffs and subordinates are hereby required particularly to attend to this order, and obtain observance of the same, and denounce to the authorities of the Marshlands all who may disobey or attempt to disobey the same.

(Signed) ARNING, DR.
Hamburg, 19th September, 1856. Senator for the Marshlands.

No cattle intended for the English market are brought into Hamburg by the ships from Tönning or the other ports on the coast of Denmark, but they go direct to England; nor are many conveyed there for this purpose by means of the navigation of the Elbe from Central Germany. "The Order in Council," at the time of our visit in April, did not appear to be understood by the exporters of cattle as to the intention of the Government with regard to this port, and they refrained at first from shipping cattle, although Hamburg was not named in the prohibition, for fear that on their arrival in England they should be seized by the Commissioners of customs.

We were informed by Colonel Hodges, Consul-General at Hamburg, that a similar doubt existed with regard to hides, and further that the order would be inoperative for good, presuming that the seeds of a contagious disease could be conveyed by these articles of commerce, so long as Hamburg, as the port of the Elbe, and Bremen, as the port of the Weser, were left open, as large quantities of these commodities come down those rivers. The hides are collected from various countries, and it is impossible to trace them to their original source. The merchants of Hamburg, however, continued to export hides, first making a declaration before the consul that they did not come from Lübeck or any of the Baltic ports. The consul upon this certified that such declaration had been made, and thus left our Commissioners of Customs to deal with the question as they might see fit. Should the necessity unfortunately arise to prohibit the importation of cattle, hides, hoofs, &c., from fear of introducing a contagious disease, such as the rinderpest, then not only must Bremen and Hamburg be named in the order, but Tönning also, as the port of the Eider, as this place has direct water communication with the port of Kiel on the Baltic, from which place hides, hoofs, &c., can be readily conveyed.

Little fear, however, need to be entertained of the introduction of the disease from Denmark by means of any *cattle* which she might receive from the Baltic ports. The difficulties in the

way of a *direct* trade of this kind are too great for it to be carried on with facility or advantage. Such cattle would have to make the port of Kiel, and be then disembarked in order to be placed on the vessels navigating the canal which connects Kiel with the Eider, and on reaching Tönning be again re-embarked on vessels bound for England.

Denmark, Schleswig, and Holstein.

In September last it was officially communicated to the Government that "the *steppe murrain of Russia had made its way into Holstein*," having passed through Poland, Prussia, and Mecklenburg. We ascertained, however, that this disease had had no existence in this part of Europe since the occasion of its last general outbreak in 1813. It is also recorded that up to that time the affection had not prevailed in the Duchies since 1774 to 1781, when 150,000 head of cattle are said to have perished.

Pleuro-pneumonia is rife in Holstein, particularly in the neighbourhood of Altona, where an active cattle-trade is carried on. The malady is said originally to have appeared here in 1842, or nearly about the same time that it was first observed in England. At the commencement of 1843, Herr Röttger, district veterinary surgeon of Altona, received orders from the Danish Government to watch the progress of the disease. No active means to limit its extension were, however, had recourse to until 1845, when the Government sent Professor Witt, of Copenhagen, to investigate the matter. Professor Witt and Herr Röttger, with a surgeon and the Government veterinary surgeon of Hamburg, formed a sanitary commission of inquiry. The commission came to the conclusion that the disease was highly contagious, and recommended the Government to adopt the most stringent measures of prevention. These consist in chief of—

a. Sequestration of the places where the disease is found to exist.

b. The immediate slaughter of the infected animals.

c. The killing of the whole herd upon the occurrence of fresh cases.

d. The burial of the diseased cattle with their skins on, cut in such a manner as to prevent their being surreptitiously disposed of, and the sprinkling the body over with chloride of lime.

The indemnity consists of the Government paying two-thirds of the value of the diseased animals, and the full value of the healthy, the loss to the treasury being partly provided for by the Government selling by public auction the carcases of the animals which are free from disease.

For the carrying out of these regulations, it is ordered among other things that every proprietor of cattle shall, upon the out-

break of a disease which seems to possess some unusual features, give notice to the district veterinary surgeon, or be subjected to a fine varying from fifty to a hundred thalers. The veterinary surgeon has to report the result of his examination to the police, and if it should prove that the malady is a contagious one, then the regulations are strictly enforced. The animals are valued on the part of the Government, and branded on the horns for the purpose of identity. Should no other cases occur after the diseased animals are killed, then the proprietor is prevented selling any of those which had been exposed to the contagion, and which bear the Government stamp, in a less period of time than six months, and only then with a certificate from the veterinary surgeon that they are free from disease.

The adoption of these severe measures led, it is believed, to the nearly total extinction of pleuro-pneumonia in two or three years. In 1847, however, it again prevailed in Holstein, also commencing, it is said, in the neighbourhood of Altona. In 1849 and 1851 other outbreaks occurred; the disease extending on the latter occasion into Schleswig and Denmark proper, but was quickly suppressed by the severity with which the law was executed.

The outbreak from which the country is at present suffering took place in the spring of 1856. It is attributed to the circumstance of two gentlemen of Hamburg purchasing in Hungary 180 oxen, and sending them to graze on the islands and marshlands of the Elbe. The disease manifested itself in these animals, and from them it was communicated to some cows which were sent daily from the town of Hamburg to graze in the same pastures, and was thus spread over the territory and the adjacent portions of Holstein. This called for the re-adoption of the preventive measures previously alluded to, and which are still in operation in the Duchies, but modified to some considerable extent in the town and territory of Hamburg.

The almost simultaneous appearance of pleuro-pneumonia in Mecklenburg, which is said to have arisen from the introduction of some cattle from Bavaria, together with its existence in several of the German States, led the government to issue the following order with reference to the importation of cattle into Holstein and Lauenburg.

Legal and Ministerial Journal for the Duchies of Holstein and Lauenburg.

Copenhagen, 18*th June*, 1856.

PROCLAMATION for the DUCHIES of HOLSTEIN and LAUENBURG, in reference to the IMPORTATION of HORNED CATTLE from abroad.

Whereas, according to official information, the pulmonary epidemic has recently shown itself again in horned cattle in several German States, the

importation of horned cattle from abroad will not, until further notice, be permitted into the duchies of Holstein and Lauenburg, unless satisfactory certificates, issued by authority, be handed in at the same time, stating the place from whence the cattle have been brought, and that in such place no signs of the pulmonary epidemic have appeared for more than six months, the cattle being therein described as accurately as possible.

The above is hereby made known for the information and guidance of those who receive it; and at the same time the police authorities are especially directed to see to the strict observance of the above order.

Royal Ministerial Department for the duchies of Holstein and Lauenburg, 9th June, 1856.

(Signed) V. Scheele.
G. Harbou.

Pleuro-pneumonia, however, continued to prevail in Holstein, despite all the measures precautionary or otherwise, which were had recourse to, and this led the minister to issue new regulations during last year, to stay if possible its further progress. It was thereupon ordered that "*all estates* (farms) *in which cases of pulmonary disease had occurred within the last six months, are to be closed, and no removal of cattle from such estates is to be permitted. The cattle are to remain as much as possible in the same stalls, and only to be removed to the pasture grounds of the owners, which are to be fenced round to the exclusion of all other cattle, as it is deemed necessary to remove cattle from their infected stalls to purer air.*"

In July, 1856, Schleswig placed the importations into her territory from Holstein under restrictions, but as these also proved to be insufficient the minister of this Duchy, in March of the present year, forbad the importations entirely.

In August, 1856, Denmark, by the Minister of the Interior, likewise ordered that no cattle should be permitted to enter the kingdom from Holstein, unless they were accompanied by a certificate of a veterinary surgeon, stating that they were in good health when exported, and also by the certificate of a magistrate, that the district from which they came was free from disease. And in September following proclamation was made to a similar effect by "the Senator of the District of the Marshlands of Hamburg," a copy of which has been given in the preceding page.

This succinct history of the proceedings of foreign governments enables us to trace to their probable origin those restrictive laws which have created so great solicitude in England. We could hardly have supposed that such severe measures would have had the support of scientific men, more especially in their exclusive application to a disease, whether contagious or not, the antecedents of whose history show that it often passes from country to country as an ordinary epizootic affection. Without wishing to animadvert on the opinions of others, we hold that an equal amount of good would attend measures far less stringent; and if this be so, then a positive injury is inflicted on the country

where they are enacted. Take as one illustration the quantity of food which is lost to the people by the burying of animals, in whose system the malady has made but little progress. We are exceedingly jealous lest any observations of ours should be supposed to give encouragement to the sale of diseased meat, but after fifteen years' experience of pleuro-pneumonia in this country, and of the sale of the carcases of animals, the subjects of it, we do not hesitate to state that the flesh is fitted for food in the early stages of the affection.

The surprise in the continuance of the system of killing and burying bovine animals becomes the greater when we see it adopted in a country where the sale of horseflesh, as an article of food, is both legalised and encouraged by the government. In Altona we passed by the shop of one of these horse-butchers, and saw exposed for sale part of the hind quarters, and sundry pieces of the flesh of a horse, and also the liver and kidneys of the animal. We were tempted to walk in, when we were informed by the proprietor that there were four other establishments of the same kind in the town, but that his was "the original one." He said that so ready a sale was found for the meat that it was with great difficulty he could procure horses enough for his customers. The price ranged from about *2d.* to *3d.* per lb. English money, and it appeared that the meat was often bought by persons who could not be properly said to belong to the lower classes. We were invited to see the establishment, and visited the slaughter-house and stable. In the former, besides more meat, was hanging the lower part of the fore leg, with the foot of the animal last slaughtered, which had been put aside for the inspection of the police; and in the latter were standing two aged and worn-out horses waiting their turn to be led to the stake. These butcheries are licensed by the government, and are under the supervision of the police. Notice has to be given before a horse can be killed, when the veterinary surgeon of the department attends and examines the animal, and if found to be free from constitutional disease, notwithstanding it may be incapacitated for work from lameness or other defects, he certifies to that effect, and for the sake of identity brands the animal on its hoof. Within a given time the animal must be killed, and its leg and foot produced for the inspection and satisfaction of the police.

Sweden and Norway.

We find, by a perusal of official documents which have been placed at our disposal, that the fear of the introduction of pleuro-pneumonia from Holstein, led the government of Sweden to interdict the importation of cattle from that Duchy in Aug. 1856,

unless accompanied by satisfactory certificates of health. The importation also of cattle from England and Scotland into Sweden was prohibited in the same month. These precautionary measures on the part of Sweden were quickly followed by the promulgation of similar ones by the government of Norway, being in each case evidently founded on the belief that contagion is the chief, if not the only, cause of the spread of pleuro-pneumonia.

Lübeck.

From the circumstance that her Majesty's Government, by "the Order in Council" of April 2nd, saw fit to prohibit the importation into England "of cattle, horns, hoofs, raw or wet hides or skins of cattle, which shall come from, or shall have been at any place within the territories of the free city of Lübeck," as well as other places named in the said order, it was to be expected that the so-called "steppe murrain" (rinderpest) would be found to be prevailing among the cattle of Lübeck. We were informed, however, immediately on our arrival, that no such disease existed, and we had ample opportunities of subsequently confirming the correctness of this statement. Indeed rinderpest has never shown itself in the territory since 1813-15, when by the movement of troops throughout Europe it prevailed rather extensively both here and also in most countries of the Continent.

The precautionary measures which were taken in the spring of 1856, by the Senate of Lübeck, had *especial reference to pleuro-pneumonia*, which disease had somewhat suddenly made its appearance in the adjoining Duchies of Mecklenburg-Schwerin and Mecklenburg-Strelitz. Some doubt, however, was felt in this country as to whether the "steppe murrain" had not found its way thence from Prussia: and this was considerably increased by the official reports of Mr. J. A. Blackwell, who up to the beginning of the present year was British Vice-Consul at Lübeck. In two despatches dated respectively May 17th and 30th, 1856, Mr. Blackwell informed her Majesty's Government, through the Consul-General at Hamburg, that a contagious pulmonary disease or murrain had broken out among the cattle in Mecklenburg; and after giving the particulars of the precautionary measures adopted by the Lübeck authorities to prevent its entrance into their territories, he states that he had consulted several of the best German authors on the contagious maladies of cattle, and found that they made a distinction between "*rinderpest* and *pulmonary murrain*;" but he adds, "*both are equally contagious and almost equally fatal, and in a sanitary point of view may in fact be regarded as identical.*" Mr. Blackwell next gives in the

despatch of May 30th an epitome of the works in question, and under the heading of the STEPPE MURRAIN, he says, that "it has been calculated that during the last century alone this murrain carried off 28,000,000 head of cattle in Germany; and in the whole of Europe, including Russia, but exclusive of Siberia and Tartary, upwards of 200,000,000;" and that "*although the disease which has broken out among the horned cattle in Mecklenburg seems to be regarded as the pulmonary murrain,*"—pleuro-pneumonia—"*it may perhaps be the real steppe murrain, which is now raging in Poland to a fearful extent, notwithstanding the stringent measures that have been adopted by the Russian Government for putting a stop to it.*"

In a despatch dated Sept. 17th, the same gentleman reports that *the murrain* had extended to Holstein, and that in consequence of this the regulations of the Lübeck government were enforced with regard to that Duchy as well as Mecklenburg. He concludes his communication by observing that, "*as this highly contagious murrain has spread from the Steppes of South Russia, through Poland, Prussia, and Mecklenburg to Holstein, to a district from which the English market is supplied with cattle, I must beg leave to call the attention of her Majesty's Government to my Report of its origin, progress, treatment, symptoms, &c., transmitted on the 30th of May last.*"

These statements could not fail to add to the alarm which was originally felt in this country, and when it is considered that for several months afterwards scarcely a week elapsed without intelligence reaching us that "the cattle murrain" was spreading, the surprise becomes the greater, rather than otherwise, that some measures of a preventive nature were not earlier adopted by Her Majesty's Government. It is true that the reports from other British consuls did not fully bear out Mr. Blackwell's statements, but still nothing satisfactory could be learned of the true nature of the malady, and up to the time of the three National Agricultural Societies determining on sending a commission to investigate the subject, the English public were left in a state of uncertainty and doubt.

In Oct. 1856, the restrictions against the entrance of cattle into Lübeck from Mecklenburg were removed, as the disease appeared to have ceased there; but they were again enforced in February following, as the malady had reappeared, and on our arrival they were still in full operation.

The regulations which had been enforced by the Senate to guard against the introduction of contagious diseases are as follows. They have been established for several years, and are only modified from time to time according to the places in which such diseases are known to prevail.

"1. Every owner of cattle is required, in case any disease should break out among the same, which leaves no doubt of its contagious nature, to separate the diseased from the other cattle.

a. The special symptoms of *lungenseuche* (pleuro-pneumonia) are a husky cough, which is increased particularly after the cattle have been watered or moved about, less inclination for food, indifference as to chewing the cud, dulness of the hair, and its rough appearance in particular places; and fever after these symptoms have continued for some time.

"2. On the appearance of this disease, or even in cases when it is suspected to exist, the owners of cattle are required, under a penalty of a fine of 20 dollars (about 3*l.* 10s.), to give immediate notice to the chief of the police or to the bailiff at Travemünde, who will take the necessary steps to arrest the progress of the disease.

"3. The bringing in of cattle into the Lübeck territory from the Grand Duchies of Mecklenburg-Schwerin and Mecklenburg-Strelitz, shall only be permitted when the cattle are accompanied by satisfactory certificates of their being free from disease.

"4. All veterinary surgeons are directed, in case this disease should break out within the Lübeck territory, to adopt the necessary sanitary precautions according to the instructions of the police. The directions of the veterinary surgeons are implicitly to be obeyed under penalty of heavy fines and imprisonment.

"5. Finally, all police officers, bailiffs, and gens d'armes are hereby directed to give notice to the respective police-offices in case any horned cattle should be attacked with the pulmonary disease, or even in cases where it is suspected to exist.

"Given at Lübeck in the Assembly of the Senate, this 14th day of May, 1856.

"(Signed) C. TH. OVERBECK, Dr., Secretary."

Besides these measures of precaution special instructions are issued for the guidance of veterinary surgeons when the disease has entered the territory; these are—

"1. That on the appearance of pleuro-pneumonia immediate notice should be given to the police authorities.

"2. That the affected cattle are to be forthwith separated from the healthy and removed to a distance. If they are put to grass the meadows must be divided by good fences and must be at the least five hundred paces distant from any in which other cattle are kept.

"3. That the persons who tend cattle are to be directed to note carefully the feeding and ruminating of the animals, and on the slightest indication of disturbed health, to have them professionally examined.

"4. That an Inspector duly conversant with disease is to be specially appointed to attend the sick cattle, and that without his permission no animal is to be returned to those which are healthy.

"5. That all animals which die are to be buried 5 feet deep and covered over with compact earth; that the burial-places are to be not less distant than 800 paces from any road or paths travelled by cattle, and that they are afterwards to be surrounded by a strong fence or a ditch.

"6. That the diseased cattle are only to be driven in particular roads; that the stables in which they were placed when attacked are to be carefully cleaned and the manure to be covered over with earth.

"7. That none but medical officers are to make post-mortem examinations, and these only by permission of the police authorities, and that no part of the carcase is to be taken away or used with the exception of the skin.

"8. That for the removal of the dead animals special vehicles are to be provided, and these are to be kept in proper places and not used for any other purpose. Persons attending upon the sick cattle, or coming in contact with them or with the dead, are not to go near healthy animals, and are to take care that all tools or utensils they may have used are properly cleaned.

"9. That no manure or fodder is to be sold from off an infected farm.

"10. That no animal however slightly affected is to be killed for food—great vigilance must be used in respect to this order.

"11. That after the disappearance of the disease from a commune or farm for a period of *eight* weeks, it is to be considered as being free from the malady, but that for *four* weeks longer the proprietor is not to sell any cattle or other forbidden things from off the place."

It does not appear that any law is in operation to prevent the importation into the territory from Russia or other countries of skins, horns, hoofs, or tallow; but we were informed by M. Tollhausen, the French Consul, who was acting also *pro tem.* as British Vice-Consul, that the official returns show that from 6000 to 8000 only of dry hides annually enter the port of Lübeck from Russia, for transit inland, while from Mecklenburg and the surrounding countries 80,000 skins are received. These are mostly either salted or fresh, and as such are too heavy for transit to a distance, besides being otherwise unfitted for such a purpose; they are therefore further prepared and dried in Lübeck, and then sent onwards to Belgium, Rhenish Prussia, &c., and up the Rhine even as far as Switzerland. No exports of cattle take place from Lübeck by means of the shipping, nor are any imported in this manner from the Baltic or elsewhere, the supply which is needed being sent over the frontier from the surrounding Duchies. Besides this we could not ascertain that any cattle have ever been shipped for England from any of the Baltic ports. The difficulties attending such a voyage and the time it would occupy are sufficient barriers against a trade of this description being carried on, even if no facilities existed for the transit of cattle inland.

Young stock, however, to the amount it is said of 50,000 a-year, pass through the territory of Lübeck from Holstein into Mecklenburg for the supply of the dairies and farms. These facts cannot fail to be of importance for legislation, if hereafter it should unfortunately be the case that the rinderpest should extend thus far westward and in a direction from which foreign cattle are shipped for England.

Mecklenburg-Schwerin and Mecklenburg-Strelitz.

It was from these Duchies that some of the earliest accounts reached England respecting "the murrain," the appearance of which promptly led the senate of Lübeck to interdict the passage of cattle into its territory, unless accompanied with a certificate of their being in a perfect state of health, and created also much

anxiety as to whether the malady might not soon extend to our own country. The alarm, however, seems to have arisen out of the circumstance that pleuro-pneumonia, which had occasionally of late years affected the cattle in Mecklenburg, in common with other Continental states, showed itself somewhat suddenly in March, 1856, at the village of Great Göruon, near to Sternberg. Its outbreak is attributed to the introduction of some cattle from Bavaria; and it appears that the "court cattle which were in the same stable" were subsequently attacked. After the death of several, the remainder of the animals were killed, and buried entire.

This summary proceeding appears to have arrested the disease in that particular village, but cases are said to have occurred in other parts of the Duchies. The interdict which was laid on the estate of Great Göruon concerning the "export, import, and transit of cattle immediately on the outbreak of the disease," was not, however, removed until Oct. 1st of the same year, after which time free intercourse was allowed. On this fact being officially communicated to the authorities at Lübeck, and also that the whole of Mecklenburg was free from the disease, the Senate removed the restrictions which had been placed in the way of cattle entering their territory; but, as has been observed in that part of this Report which specially refers to Lübeck, they were again enforced in February of the present year, in consequence of the reappearance of the disease in the duchies of Mecklenburg.

On the 24th of December, 1856, the Commissioners of our Customs published an order with regard to a more rigid examination by the Inspectors of Foreign Cattle, "with special reference to a contagious disease called 'murrain,' which has recently broken out amongst the horned cattle of Mecklenburg." Count Bülow, Minister to the Grand Duke of Mecklenburg-Schwerin, complained of this order to Lord Blomfield, her Majesty's ambassador to the court of Prussia, and requested that the attention of the Home Government might be directed to it, and Lord Blomfield thereupon sent a despatch to the Earl of Clarendon, to the following effect:—

"My Lord, "*Berlin, January* 23, 1857.

"I have the honor to inclose to your Lordship herewith a copy of a communication which I have received from Count Bülow, Minister of his Royal Highness the Grand Duke of Mecklenburg-Schwerin, requesting me to draw the attention of her Majesty's Government to the injurious effects which the publication of the Custom-house Order, published in London the 24th December, 1856, respecting the importation of cattle, alleged to be diseased, from the Mecklenburg States, is likely to have on the commerce of the country. Count Bülow states that 'the cattle murrain,' alluded to in this order as now existing in Mecklenburg, has only manifested itself twice, for a

short period, during the years 1855, 1856; and that in each case measures of such a stringent nature were taken as effectually arrested the spreading of the disease, insomuch that since the 1st October last all the measures of precaution that were in force for its prevention have been suspended by the official order to this effect, copy of which Count Bülow has transmitted to me, and which, in original and translation, I have the honour to forward herewith to your Lordship.

"I have, &c.
"(Signed) Blomfield."

From this and all the additional information which we have collected, it would appear that there was very little cause for danger to be apprehended, and none, in so far as our country was concerned, from the state of the health of the cattle of Mecklenburg, the so-called "murrain" being only the affection known as pleuro-pneumonia.

Saxony.

This kingdom is perfectly free from rinderpest, and has been so for many years. Scarcely any apprehensions are entertained that the disease would reach the country, even if it were to encroach very much more upon the Prussian frontiers of Russia and Poland, or prevail to a far greater extent than it has recently done in Silesia, as the severity with which the preventive laws of those countries is carried out is viewed as affording all the security which is required. Eczema epizootica has been somewhat rife of late, and many cases are still to be met with. Pleuro-pneumonia has only existed in a sporadic form in Saxony and Central Germany, and has therefore not excited a great amount of public attention. The laws in force with reference to cattle diseases are almost identical with those which have already been made mention of in this Report.

The investigations in Saxony completed our inspection of the chief course of the river Elbe, and showed that all the countries through which it flows were entirely free from the rinderpest, a result equally as satisfactory as that which had previously been ascertained with reference to the Weser.

Prussia.

Finding that the rinderpest had no existence in the countries we had already passed through, we proceeded to Berlin, with a view of going to Königsburg, and thence into Courland, as, according to the information we were at present in possession of, it was here that the malady was prevailing to some considerable extent. Arriving at Berlin, we first called on the professors of the Veterinary School, who, by virtue of their appointments under Government, are always put in possession of the latest information with regard to the existence and extent

of contagious diseases among domesticated animals. From them we learned that the entire district we had proposed to visit was now perfectly free from the pest, and that, if it existed anywhere in Prussia, it would probably be found in the neighbourhood of Breslau, in the province of Silesia. They also further informed us, that there was but little chance of our being able to study the nature and symptoms of the pest in any part of the Prussian dominions, from the summary proceedings which are invariably had recourse to for its immediate extirpation, and that for the purpose of seeing the malady in its different stages, we should have to go into Austro-Poland, or some other part of the Austrian empire, where the laws are somewhat less stringent and not so rigorously enforced as in Prussia. We ascertained also that in all probability, in the event of our succeeding in obtaining an entrance within the Prussian military *cordon*, we should not be allowed to repass it in a less period than three weeks, and even then we should most likely have to leave the clothes we had worn behind us, besides having ourselves to undergo a disinfecting process.

Under these circumstances we sought an interview with Lord Augustus Loftus, her Majesty's *Chargé d'Affaires*, in the absence of Lord Blomfield, minister at Berlin, with a view of obtaining from the government of Prussia the latest particulars with regard to the location of the malady, and that amount of assistance and protection which we needed for the fulfilment of our mission. This interview was at once granted, and we were most courteously received by his Lordship, who manifested the liveliest interest in the question, and also expressed his willingness to do all he could in furtherance of the object. His Lordship explained at some length his views as to the absolute necessity of the keeping up of a strict *surveillance* over all articles of commerce which were likely to carry the *materies morbi* of the disease, and of the danger which would be incurred in the event of its extension by allowing the importations to go on from the great ports of the Weser and the Elbe, facts which have already been alluded to in the former part of this report. Lord Loftus also dwelt on the amount of danger which might probably arise from the free importation of bones from Russia and the Baltic ports, and instanced a case where an outbreak of the malady was believed to have depended on the conveyance of the bones of an animal dying with it into a stable in which other cattle were placed. His Lordship requested that I would write to him stating the object of our inquiry and the requirements we needed from the Government. He also promised that he would put himself in immediate communication with Baron Manteuffel, and would write also to his Excellency Sir Hamilton Seymour,

her Majesty's ambassador at the Court of Vienna, to procure for us letters of introduction and recommendation to the authorities in the Cracow division of Galicia, in the event of its being found necessary to go thus far to complete our inquiry. A letter containing his Lordship's suggestions was thereupon forwarded to him, and to this I had the honour of receiving the following reply:—

"Sir, *"Berlin, April 23, 1857.*

"I beg to acknowledge the receipt of your letter of this date.

"I enclose to you herewith copy of a letter I have addressed to Baron Manteuffel, requesting H. E. to give you a letter of recommendation for the proper authorities at Breslau; and I shall not fail to forward to you, without delay, H. E.'s reply.

"I shall likewise request Sir H. Seymour to procure for you a similar introduction to the authorities at Cracow, and shall further beg him to forward the reply to your address, 'Poste restante à Cracovie.'

"I have, &c.,

"Augustus Loftus.

"*Professor Simonds, Hôtel Victoria, Berlin.*"

His Excellency Baron Manteuffel readily complied with the request thus made, and being now furnished with all necessary letters of recommendation, we made our way as quickly as possible into Silesia; and, arriving at Breslau, at once reported ourselves to Baron Schleinitz, by whom we were also most courteously received, and who had already prepared for our use a written account of the progress which the disease had made in the spring of the present year in his province. The Baron met us by somewhat facetiously remarking, "that, fortunately for Prussia, but perhaps unfortunately for us, who had travelled so far to study the nature of rinderpest, it had no existence just now in Silesia." He traced, however, upon the map the different places where the disease had recently prevailed near to the Polish frontier, and which he himself had visited. He likewise related several remarkable instances of the highly infectious nature of the disease, and of its conveyance from place to place by *indirect* means of contagion. The following is a translation of the Report alluded to:—

"*Report of the Disease which prevailed among the Horned Cattle in the Province of Silesia during the Months of March and April,* 1857.

"The rinderpest, which in the present year has visited the province of Silesia, has, with one exception, in which the precise manner that the infection was carried to the premises could not be satisfactorily ascertained, been clearly traced to the introduction of two herds of cattle from Galicia, of the Podolian or Hungarian breed, numbering respectively 44 and 37. These beasts were purchased by different landowners, and were brought to their several estates in an apparently healthy condition. Some of the animals have remained in

health, as, for example, those which were taken to L. Guttentag, in the circle of Lublinitz, and to Blazeiowitz, in the circle of Tost-Gleiwitz, but others of them became the subjects of the disease.

"The Government District of Breslau.

"Eight oxen were brought to the domain or estate of Fürstenau, circle of Neumarkt, and were put into a stable with some other cattle. In a few days the eight oxen fell ill, and, on the disease being recognised as the rinderpest, they were immediately slaughtered. They had, however, already infected the others, and, on several becoming diseased, the whole herd, consisting of twenty-one animals, was likewise slaughtered. On the same estate there were *eighty* cows, but these were living in other sheds, and did not come in contact with the diseased animals; and, moreover, in the same village there are upwards of *one hundred cattle-owners*, but the whole of the cattle were preserved by the summary measures had recourse to. The sanitary *cordon* drawn around the estate was removed twelve days since; three weeks having elapsed since the last case, and everything used about the animals being disinfected.

"The Government District of Oppeln.

"1. Twenty oxen were brought into the estate of Schwieben, in the circle of Tost-Gleiwitz, and on their arrival they were distributed to the different stations (farms) of the estate. The disease also broke out among these animals, and, as they sickened, they were removed to a station where only sheep were kept, and here slaughtered. A military cordon was also drawn around the place. Notwithstanding this precaution, the disease spread; thus—

"*a. In Schwieben* one ox was attacked, and he, with another with which he was standing, was immediately killed. The further progress of the disease was at once arrested, although there were 120 head of other cattle on the estate, and in the village also about a hundred cattle-owners.

"*b. Station Radun.*—An ox which showed premonitory symptoms was immediately killed, together with another that he was standing next to, and no other cases have occurred.

"*c. Station Wischnitz.*—The appearance of the rinderpest at this station is very remarkable. It appears that either four or six of the Podolian oxen were sent here and remained for a few days. These animals gave no evidence of being affected, but *twenty* days after their departure one animal of a herd of 19 that they had been placed with fell ill with the disease, and the whole were forthwith slaughtered.

"2. Estate Ponischowitz.—Twenty Podolian oxen came here on the same occasion, and they within a few days gave indications of being affected. Like the others, also, they had been put with other cattle, 49 in number. On the occurrence of the outbreak the whole were killed, so that not a single head of cattle was left on the estate. The place was likewise surrounded by a military cordon; but while the disease was going on, a carpenter's apprentice, employed on the estate, escaped the vigilance of the guards, and went to his father's house, which was distant about two thousand paces. While there he repaired a manger in his father's cow-shed, and also changed the clothes he had worn at Ponischowitz. The rinderpest in consequence of this broke out among his father's cattle. The whole were thereupon killed, and a military *cordon* drawn around the premises. It is now ten days since the animals were slaughtered.

"3. At Slupsho, four of the Podolian oxen sent here were attacked. They were likewise slaughtered, and the further progress of the disease arrested. The *cordon* has been raised here four weeks; the place having been previously disinfected.

"4. At Zawaiz, in the circle of Beuthen, at a totally isolated farm, a case of sudden death occurred to an ox, which the surgeon reported as happening from rinderpest; but there is considerable doubt as to this opinion being correct.

"5. At Wohlau, in the circle of Pless, close to the frontier of Galicia, and into which no cattle had been imported, three cases of the disease occurred, and all at peasants. These animals had come in contact with nine others, and all were consequently killed and a military cordon established. In this particular instance it was impossible to trace the cause of the introduction of the disease.

"These are all the cases of rinderpest which have recently occurred in the province of Silesia, and at the present time not a single suspicious case exists, owing to the means which the Government has adopted to arrest its course. No fear need be entertained that the disease will extend from Prussia to the neighbouring countries.

"Breslau, April 27th, 1857.

"(Signed) Baron Schleinitz,
"Privy Counciller to his Majesty the King of Prussia, and
Upper President of the province of Silesia."

It will not be necessary to comment on this Report in this place, and more particularly as we shall have hereafter to adduce some remarkable proofs of the contagious nature of the rinderpest. It is right, however, as several parts of Prussia have experienced during the last two years different outbreaks of the malady, and as its extension in this kingdom especially is an object of much practical importance, as thereby a greater risk is incurred of its reaching those countries which are in direct communication with our ports, that as complete a history of these recent visitations should be here given as we have been able to collect.

The Recent Outbreak of the Rinderpest in Eastern Europe.

Throughout the late war the movements of the Russian troops necessarily called for the transit of large numbers of cattle to those places which the army successively occupied, and it appears more than probable that the wide diffusion of "the steppe murrain," which has occurred within the last three years, has depended entirely upon this cause.

The ordinary traffic in cattle leads, it is true, to the annual removal of large herds from the steppes, and hence the outbreaks of the rinderpest, in those countries which are otherwise free from it, can often be traced to the animals which find their way from various fairs and markets. No cause, however, is so potent in the spread of the disease as the outbreak of a Russian war; and consequently, whenever circumstances have required the passage of her troops over the frontier, the pest has manifested itself in a far more extensive form. Thus it is recorded

that, "during the Russo-Turkish war in 1827 and 1828, the Russian cattle which were sent for the supply of the army carried the murrain with them, and that it destroyed no less than 30,000 head of cattle in Hungary, 12,000 in Galicia, and 9000 in Moravia."

Again, in 1831, 1832, and 1833, in consequence of the Polish insurrection, the disease committed great ravages in that country, causing considerable distress. At this period it also crossed the Prussian frontier, in the department of Bromberg, and, although quickly exterminated, swept away nearly one thousand head of cattle.

In 1849-50 the malady again prevailed to a very great extent in Hungary; its introduction being due, according to the official report of MM. Renault and Imlin, Commissioners appointed by the French Government to inquire into the subject, to the passage of the Russian troops from Wallachia by way of Transylvania.

Very shortly also after the army of Russia was sent to occupy the Principalities, rumours of the cattle-plague became current. We find that as early as 1854 the disease had made considerable progress both in Volhynia and Podolia. From that period nearly down to the present the malady gradually extended itself, until it reached most of the countries in eastern Europe, and some parts even of Asia Minor. From the Principalities it can be traced in a northerly and westerly direction into Moravia, Galicia, Poland, Prussia, Lithuania, &c.; easterly into Bessarabia, Southern Russia, and the Crimea; as also into Turkey, and to the southern shore of the Black Sea.

We have not been able to arrive at any correct estimate of the immense losses these several countries sustained in consequence of this visitation; but it has been officially reported that no less than 26,442 head of cattle were destroyed in the Austrian dominions in the year 1856. And Consul-General Mansfield, in a despatch from Warsaw, states, that from May 9th, 1856, to the date of his report, March 29th, 1857, twenty thousand beasts had been sacrificed in Poland alone. It has likewise been said that the French army lost in Samsoun 8000 beasts out of 17,500 in the space of nine months, and that we lost during the same time 4000 out of 10,000 from the pest; facts which may help to convey an idea of the hundreds of thousands which were swept away.

Mr. Radcliffe, M.R.C.S., who lately held a commission in the Ottoman army, reports that, while he was stationed at Sinope, the murrain was developed towards the termination of the spring or early part of the summer of 1855, and that in the month of June it reached its acme. "Scattered cases," he adds, "occurred, however, from time to time until November,

when, about the second or third week of the month, the disease broke out again with great fierceness, spread rapidly among the cattle in the depôt and in the town, reached a second acme about the termination of the month, declined during December, and ceased altogether in January, 1856."

Among many others, also, Mr. Walton Mayer, V.S. to the "Royal Engineer Field Equipment," who was, during the war, attached to the Land Transport Corps, speaks of the existence of the disease in several parts of Turkey, and in the immediate neighbourhood of Constantinople, in the summer of 1855. Early in the same year, in consequence of a considerable part of both Austrian and Russian Poland having become the seat of the disease, much apprehension was shown lest it should cross the Prussian frontier. To prevent this the Prussian Government took the precaution of sending detachments of troops to all the points of egress below Thorn, with a view of cutting off the communication with the infected localities.

Baron Schleinitz, President of the department of Bromberg, in the province of Posen, in his official report, says, that "it was in the month of March, 1855, that we were obliged to order the frontier to be closed, which was first effected in pursuance of the directions in section 2 of the law of 1836. In October of the same year we were under the necessity, in consequence of the threatening approach of danger, of putting into force the severer directions of section 3 respecting the closing of the frontier; and when, at the end of that month, intelligence, though not officially confirmed, arrived here regarding the progress of the murrain, we caused the Polish district bordering upon our department to be thoroughly investigated by the veterinary surgeon of our department within a distance of three miles from the boundary of our territory."

"It being then ascertained that the disease was only 2½ miles from our frontier, we determined, at the beginning of November, to close the same still more strictly, according to section 4 of the said law. At the same time we ordered the district commissaries of police to inform the mayors of the different places of the impending calamity, who were not only instructed to exhort the inhabitants of their districts to use the greatest precaution, but also to give immediate notice, per express, to the Counsellor of Administration of the district of every suspicious case of disease breaking out among the cattle. As a further warning and instruction to the public, we caused copies of the circular which was issued by the chief magistrate of our province, under the date of 28th of January, 1845, to be printed and distributed, to which we annexed a description of the symptoms of the disease, and caused the same to be distributed as a supplement to our

official paper (Gazette). Besides this, we prohibited the attendance of persons at the weekly markets of the towns lying nearest to the threatened boundary with those species of cattle, as well as with other things likely to convey infection, and which the law of 1833 specially enumerates; we likewise ordered establishments to be erected for personal purification in the villages wherein the frontier custom-office is established; stationed gendarmes in the villages on our side of the boundary situated nearest the infected Polish districts, and charged the district commissaries in the immediate neighbourhood, under pain of dismissal from office, with the execution of the preventive measures in case the contagion should break out in our territory. We further empowered the Counsellors of the Administration of the district to order the district veterinary surgeons to inspect the villages and places on the boundary as often as necessity required, and to watch over the state of health of the cattle there."

Notwithstanding that these precautions were rigorously adopted, the disease crossed the Prussian frontier; and in the latter part of November, 1855, it manifested itself in the circle of Inowraclaw, and shortly afterwards in the circle of Gnesen, near to the town of Posen. The official report states, that on this occurrence "general measures were taken for closing the boundaries of the places infected, and special ones for the infected farmyards, by means of sentries posted under the superintendence of gendarmes; quarantine stables were established, superintendents and cattle inspectors appointed, and these persons provided with written instructions and bound by oath to their observance; all trade in cattle was forbidden within a circuit of three miles, all dogs chained up, and every proprietor of cattle within a circuit of two miles from the infected place was bound, upon pain of incurring the penalty of sec. 309 of the Criminal Law, to give immediate notice even of the least symptom of disease among his cattle to the mayor of the place, who had forthwith to inform the Counsellor of the Administration of the district, by an express messenger, of such cases of disease, provided they did not proceed from exterior injuries."

"These measures for prevention and cutting off intercourse were in no instance abandoned before the expiration of the fourth week; and the carcases of the cattle that had died of the pest, or had been killed in consequence of its appearance in infected districts, no matter whether diseased or healthy, were always, after their skins had been cut into pieces on all parts of the body, buried in pits from six to eight feet deep, each carcase being previously covered with unslacked lime."

At the first the chief execution of these preventive means on the several farms was intrusted to civilians, but very early in

the progress of the malady the military was employed. The disease presently began to subside, but despite every precaution occasional cases occurred, so that the department of Bromberg was not entirely free from it until the beginning of 1856. The *cordon*, however, on the frontier of Poland was not raised; but on a decline of the disease in that country a removal of the impediments which had been placed in the way of trade was gradually permitted. Individuals who could satisfy the officers of the urgency of their business—which, however, must not be in connexion with cattle or cattle-offal—were, by reason of a certificate from the Counsellor of Administration of the district, allowed to cross the frontier, through the custom offices, into Poland. Upon similar conditions foot-passengers, who must, however, be furnished with only the most necessary requirements, were likewise permitted to pass into the department of Bromberg from Poland. Nevertheless all individuals crossing the frontier, together with their effects, were required to be disinfected in the establishments erected for that purpose at the boundary custom-place, under the superintendence of a gendarme.

Persons travelling post were likewise subject to the same regulations, and spun goods were not allowed to enter.

Early in 1856, namely, in the month of April, the disease also broke out in the department of Breslau in the province of Silesia. For the particulars of this occurrence we are indebted to Lord Loftus, to whom they were officially communicated by the Prussian government. The report states, "that for forty years the department had been entirely free from the rinderpest, but that the disease had existed therein during 'the War of Independence.' "All investigations have failed," it says, "to show the precise manner in which the outbreak occurred, but it appears that the disease came from the circle of Schrimm in the district of Posen. The means of its extension from the circle of Schrimm are the more obscure, because those persons who might have been the cause of the conveyance of the infection are interested in not giving correct information. A knowledge of the existence of the pest only reached the authorities at Breslau after three different circles were more or less affected, which circumstance arose from the want of experience of the district veterinary surgeons, none having had an opportunity of previously seeing the disease. Subsequently also about a month elapsed before correct reports were obtained from the Commissioners who were specially appointed for the investigation, arising from the great distances they had to travel and the difficulties which were in the way of their making *post-mortem* examinations."

"The disease lasted for seven months, and its continuance so long depended in part on the footing it obtained while the inves-

tigations were going on, as during this time many animals were inadvertently exposed to the infection, and consequently they had the malady incubated in their systems when the preventive measures were enforced. Another cause of this long duration of the malady is to be found in the difficulties which were experienced in the adoption of the sanitary laws, and the want of zeal on the part of the public in giving effect to them. In October the disease declined in the different circles, and was nearly extirpated, but about the middle of November it reappeared in the villages of Braunau and Seitsch, which doubtless depended on a second communication being established between them and some of the still infected farms." The following table shows the number of the places affected, together with the quantity of cattle kept and the result of the outbreak :—

Circle.	Number of Infected Villages.	Number of Infected Farms.	Number of Cattle kept in the Villages.	Died.	Killed.		Total Loss.
					Diseased.	Healthy.	
Wohlau	5	7	828	5	8	10	23
Steinau	4	35	487	97	78	107	282
Guhrau	15	77	4213	151	423	187	761
	24	119	5528	253	509	304	1066

The report states in conclusion, "that, considering the extent of the circles and the number of cattle kept in them, together with the length of time which elapsed before a correct diagnosis was arrived at, the loss is but a trifling one, and especially when it is compared with the thousands of animals which are sacrificed to the disease in other countries."

Subsequently to the extirpation of the pest from this part of Silesia in November, 1856, the province continued free until the month of March of the present year, when, as has been previously explained by the official report which we have inserted at page 225, on the authority of Baron Schleinitz, some villages lying near to the frontier of Galicia were affected by "the introduction of two herds of cattle from that country." It thus appears that Silesia has experienced two separate outbreaks, the first during the year 1856, and the second in 1857.

By the extension of the disease northward, Lithuania and Courland became affected, the pest showing itself in the latter-named province in the autumn of 1856, and continuing until January, 1857, with an estimated loss of 2000 head of cattle. Throughout the entire year of 1856, in consequence of the steady progress of the disease in Russian Poland, the importation of cattle, skins, bones, hair, &c., was strictly prohibited all along

the Russian frontier of Eastern Prussia. On the occurrence of cases at Kowno and Tauroggen, and particularly at Lansayen and Georgenburg, places near to the frontier in the circle of Tilset, more severe measures were adopted; the driving of cattle along the right bank of the Niemen was interdicted, and all traffic between the countries was suspended. No persons having to do with cattle were allowed to cross; or if so, they had to undergo a quarantine, while mail passengers were fumigated at the borders. In the month of August the authorities in the circle of Gumbinen were ordered to stop all the cattle and horse fairs which were to be held in the succeeding months of September and October.

By the strictest enforcement of these sanitary regulations this division of Prussia was preserved until the spring of 1857, when the malady crossed the frontier and showed itself in the villages of Bassnitzkehmen and Meldiglaucken on the 2nd and 3rd of April. The disease, however, was at once arrested by the establishment of a military *cordon*, and by the wholesale slaughter of the animals affected, as also of those suspected to be diseased, and the burial of their carcases in quick-lime in holes 8 feet deep. It was this immediate arrestation of the pest in this district which induced us, as has been previously observed, to alter our route and to go on to Silesia, instead of Eastern Prussia and Courland, with a view of studying the nature of the malady.

From the preceding particulars it appears then that since the latter part of 1855 the disease has entered the kingdom of Prussia from adjacent countries in three of its different provinces, namely, in November, 1855, in the circle of Inowraclaw, province of Posen; in March, 1857, in the districts of Tost-Gleiwitz and Lublinitz, province of Silesia; and in the following April in the villages of Bassnitzkehmen and Meldiglaucken, province of East Prussia; besides having prevailed for several months in 1856 in other parts of Silesia, coming there from Posen.

Galicia.

Leaving Silesia, we proceeded to Cracow, taking with us letters of recommendation from Baron Schleinitz to Count Clam Martinitz, President of this division of Galicia. Waiting our arrival also, we found, at the *poste-restante*, a similar communication from Sir G. H. Seymour, her Majesty's ambassador at Vienna, which was accompanied by the subjoined letter :—

"Sir, "*Vienna, April* 27, 1856.

"In compliance with the request made in your behalf by her Majesty's Legation at Berlin, I at once applied to the Minister of the Interior for the

facilities of which you stand in need, and have now the pleasure of forwarding to you the enclosed letter of introduction for Count Clam Martinitz, President of the Government of Cracow, who has already received instructions by telegraph to afford you every possible assistance in the prosecution of the inquiries with which you have been entrusted by the Agricultural Societies of England, Scotland, and Ireland, under the sanction of her Majesty's Government.

"I am, &c.,

"G. H. Seymour.

"*J. B. Simonds, Esq.*"

On calling at the official residence of Count Clam Martinitz, we were immediately admitted to an audience, when, on presenting our letters of recommendation, his Excellency expressed his entire concurrence in the object of our mission, and his readiness to afford us every facility in his power in its accomplishment. He explained that, in his division of Galicia, the malady was fast declining, but that in the circle of Neu Sandec, and also of Jaslo, a few cases would probably be met with. He likewise expressed an opinion that we might have to go as far as Lemberg to satisfactorily study the disease, as in that division of the county it prevailed to a much greater extent. In the event of this being found necessary, he kindly promised to furnish us with all necessary letters of introduction to the Governor of the Lemberg division of Galicia, as well as to the local authorities of the places we should visit in his own governmental division, and also copies of the official documents relating to the progress of the disease, and the instructions issued by the commissioners of the sanitary laws.

In the evening of the same day we had the honour to receive the following letter, with its several enclosures, two of which we here insert—namely, the statistical return of the progress of the disease, and the notice which regulates the proceedings of the sanitary Commission:—

"Sir, "*30th April*, 1857.

"I have the honour, according to my promise, to send you a letter for the Kreishauptmann of Jaslo, and another for Count Gotachowski at Lemberg. I think it proper to join one more addressed to the Kreishauptman of Tarnow (the place where you are to leave the railroad), in case you should need any assistance relating to your further journey. I send you also the papers we have spoken of.

"I am, &c.,

"*J. B. Simonds, Esq.*" "Clam Martinitz."

[Translation. Enclosure No. 1.]

"*Circular Notice of the Imperial Royal Government of Galicia respecting the Slaughtering of Cattle to prevent the spreading of the Rinderpest.*

"To prevent the spreading of this disease by the means which are at the command of the Minister of the Interior, it has been deemed expedient to issue the following orders:—

"1st. That whenever there are reasons to suspect the existence of the pest all diseases occurring among cattle shall be carefully watched, and when the least doubt exists as to the nature of the affection the animal shall be killed, and a *post mortem* examination made with a view of ascertaining as far as possible the exact nature of its ailment.

"(*a*) The disease having been declared suspicious by a medical officer duly appointed for that purpose; and

"(*b*) The local authorities having been informed by the medical officer of his opinion; they shall jointly proceed to value the animal to be slaughtered, according to the manner hereafter described.

"2. Slaughtering is to be enforced in the Austrian dominions when the rinderpest already prevails—

"(*a*) At its outbreak in places which have hitherto been free from it.

"(*b*) When the disease is well marked in its characters, symptoms, and duration, or by its violence and destructiveness, and when also the police measures which have been already taken have been without effect in checking its progress, so that there is a probability that either the malady by the slaughtering may be suddenly brought to an end, or that its further spreading may be entirely or partly prevented, to enable the communication between healthy and diseased districts to be speedily re-established.

"(*c*) The ultimate decision as to whether the slaughtering shall be enforced when the certainty of the presence of the rinderpest has been decided on, and to what extent it shall be carried, is to depend on the commissioners who are appointed for that purpose, who, after having been duly informed of the outbreak of the rinderpest or other disease of a suspicious nature, or the spreading of the same in the infected communes, shall, conjointly with those who are charged with the carrying out of the veterinary police regulations, and also, if possible, with a medical officer acquainted with the disease, and two sworn valuers, taken from the commune, who are well acquainted with the price of farm-stock, first value the cattle which it has been decided to slaughter. A special report is to be made of the proceedings to the competent authorities.

"3. With reference to the question by whom and in what manner the estimated value is to be paid to the owner of the condemned cattle, and whether it is ultimately to be paid by an order on the Treasury from the police authority of the district—

"(*a*) The owner will receive the full value ordered by the authorities, after deduction has been made for the parts that may be used, as determined by competent authorities, for the cattle which have been killed on suspicion under rule 1, with a view to ascertain if the disease was the rinderpest or not.

"(*b*) For those cattle where no doubt exists as to the nature of the disease being the rinderpest, and in those districts in the Austrian dominions which are known to be infected. And when the slaughtering shall have been ordered by the authorities, the owner shall only be entitled to receive the amount of their value on condition that he has not neglected any of the precautions which are prescribed by the veterinary police, and thereby contributed to the spread of the infection among his stock, or has in no way concealed the disease after the outbreak on his premises.

"(*c*) Under the same circumstances of the existence of the disease, the sum named by the valuers, after deducting the worth of the parts allowed to be used, such as the skin and horns, when properly disinfected, will be paid for every head of cattle killed by order of the commissioners.

"(*d*) With a view to facilitate those proprietors whose cattle have been slaughtered by the commission for the purpose of ascertaining the nature of the disease, and when it has been proved not to be the rinderpest, in replacing

ENCLOSURE No. 2.—GENERAL REPORT of the PROGRESS of the RINDERPEST in the GOVERNMENT of CRACOW, from the 1st to the 15th of April, 1857.

Cracow, 23rd April, 1857.

Circle.	Names of Villages.	Date of the Outbreak.	Number of Cattle.	Number of infected Farms.	Sick on 1st April, 1857.	Increase to April 15.	Total Number of Sick.	Recovered.	Died.	Killed.	Remained April 15.	Total from the time of the outbreak of the Disease.			
												Attacked.	Recovered.	Died.	Killed.
Sandec.	Starawieś	Mar. 21	940	1	..	..	..	..	..	..	..	26	..	4	22
	Lipowe	,, 21	182	1	..	..	..	..	..	..	..	7	..	7	..
	Rovtoka	Apr. 11	100	1	..	2	2	..	1	..	1	2	..	1	..
	Lossosina-dolna ..	Mar. 20	395	1	3	12	15	..	..	15	..	72	3	53	16
	Wronica	,, 20	262	2	4	17	21	..	10	11	..	53	1	41	11
	Paszyn	,, 25	213	1	..	10	10	..	4	6	..	12	..	4	8
	Alt Sandec	,, 31	729	1	..	..	..	..	..	..	..	6	..	2	4
	Tazowsko	,, 20	257	1	..	..	..	..	..	..	..	3	..	1	2
	Zabrzez	,, 20	453	1	2	1	3	1	..	..	2	14	3	8	1
	Kamienica	,, 30	433	1	..	..	..	..	..	..	..	44	..	32	12
	Szczawnica	,, 21	490	2	1	..	1	..	..	..	1	34	4	25	4
	Tylka	,, 20	78	1	..	..	..	..	..	..	..	11	..	10	1
	Florynka	,, 17	190	2	2	3	5	..	4	..	1	21	2	18	..
	Banica	,, 22	50	1	1	..	1	1	..	..	..	9	1	8	..
	Kruźlowa wyź ..	Apr. 6	425	1	2	..	2	..	..	2	..	4	..	2	2
	Ptaszkowa	,, 3	800	4	10	6	16	..	2	14	..	16	..	2	14
	Biala-niźnia ..	Mar. 30	258	2	10	..	10	..	..	10	..	11	..	1	10
	Biala-wyźnia ..	Apr. 4	586	1	..	1	1	..	..	1	..	1	..	..	1
	Total of 18 villages	..	6841	26	35	52	87	2	21	59	5	346	14	212	115

Jasło.	Trabarña	Mar. 15	67	1	..	4	4	..	3	..	1	9	..	8	..
	Pielgrzynka ..	,, 16	362	3	4	2	6	..	4	..	2	27	..	25	..
	Czekay	,, 14	103	1	..	..	..	..	..	..	..	6	..	3	3
	Mytarz	,, 23	198	1	..	..	..	..	..	..	..	1	..	1	..
	Foluszo	,, 16	225	1	..	..	..	..	..	..	..	6	..	1	5
	Swiałkowa	,, 30	472	1	2	2	4	..	..	3	1	17	2	11	3
	Taworze	,, 27	210	1	..	6	6	..	5	..	1	6	..	5	..
	Turaszuwka ..	,, 15	350	1	..	..	..	..	..	..	..	7	..	7	..
	Suchodol	,, 30	558	1	1	2	3	..	1	..	2	4	..	2	..
	Szymbak	,, 19	866	1	..	..	..	..	..	..	..	9	..	1	8
	Ropa	,, 29	1382	1	..	7	7	..	2	5	..	8	..	3	5
	Nieeznajowa ..	,, 28	237	1	1	2	3	..	1	2	..	3	..	1	2
	Grab	,, 15	486	1	1	..	1	1	..	..	..	16	1	12	3
	Zydowskie	,, 19	237	1	5	7	12	..	8	3	1	15	..	11	3
	Lipiñki	,, 28	875	1	..	..	..	..	..	..	..	4	..	2	2
	Total of 15 villages	..	6633	17	14	32	46	1	24	13	8	138	3	93	34
Tarnow	Dabrówka	Mar. 21	56	1	..	..	..	..	..	..	..	16	..	12	4
	Siemiechów ..	,, 28	75	1	7	..	7	5	2	..	..	42	6	36	..
	Total of 2 villages	..	131	2	7	..	7	5	2	..	..	58	6	48	4
Wadowice.	Rzyki	Mar. 20	408	1	..	2	2	..	..	2	..	7	..	1	6
	Lipowa	,, 31	92	1	..	8	8	..	3	..	5	8	..	3	..
	Wieprz	,, 29	83	1	..	5	5	..	1	..	4	5	..	1	..
	Ciecina	Apr. 4	46	1	..	1	1	..	..	1	..	2	..	1	1
	Cisiec	,, 9	40	1	..	1	1	..	..	..	1	1	..	..	..
	Total of 5 villages	..	669	5	..	17	17	..	4	3	10	23	..	6	7
Cracow	Cieszkowice ..	Mar. 30	300	1	11	..	11	..	2	9	..	11	..	2	9

TOTAL OF THE WHOLE GOVERNMENT.

5	41	..	14,574	51	67	101	168	8	53	84	23	576	23	361	169

their cattle speedily, the district authorities are empowered to order the payment to be made out of the district funds, and to duly inform the superior authorities of the same.

"4. To estimate the true value of the cattle ordered to be slaughtered by the commission, the local authorities, as well as the sworn valuers, will have to take into consideration the market value, age, and breed of every animal submitted to them.

"5. With regard to the cattle which have been killed as suspected, but which are found on a *sectio cadaveris* to be perfectly free from the disease, the flesh of the same may be used for food, and the hide, horns, and tallow as articles of commerce. Of those also which were known to be affected by the pest, or were discovered to be diseased on the making of the *post mortem* examination, the horns, fat, and hides may be used for commercial purposes, but only on the regulations framed for that end being strictly complied with, and it is ordained that in these instances the parts shall be valued and deduction made from the amount to be paid to the proprietors.

"The attention of the local authorities and veterinary police is specially directed to this point.

"Lastly. It is ordered that these fresh directions of the district government upon the necessity of the slaughtering of cattle to prevent the spreading of the rinderpest be in force from the present time.

"*Lemberg*, 17 *September*, 1850."

Immediately on the receipt of the letters of introduction from Count Clam Martinitz, we set forward on our journey to Neu Sandec, in company with Professor Nicklas, of the Veterinary School at Munich, whom we had previously met at Berlin, and who had been sent by the authorities of Bavaria on a similar mission to ourselves. Arriving at Neu Sandec, our first business was to wait upon the President of the department, who referred us to the district physician for the latest particulars as to the precise location of the disease, as the week's report had not yet reached his office.

It may be as well here to observe that in this part of the Austrian dominions there are no scientifically-educated veterinary surgeons, and that from the frequent occurrence of epizootic diseases both physicians and surgeons are appointed by the Government as inspectors of the health of cattle, and to act also as commissioners of veterinary sanitary police during the prevalence of these affections. To fit them for this purpose, they have to make this class of maladies their special study, and subsequently to undergo an examination as a test of their competency.

By the district physician we were placed in communication with M. Carl Zankel, surgeon and commissioner of Alt Sandec, who received instructions to accompany us forthwith to the different places where the disease existed, and to proceed in the first instance to a village called Lüdowica, lying at the foot of the high range of the Carpathian mountains, where a case had just

occurred, and which it was hoped that we might succeed in seeing before the animal was destroyed.

On reaching Lüdowica we were at once admitted within the *cordon*, when we found that this animal, together with nine others which had been exposed to the infection with him, had already been slaughtered and buried. An application was made to have the bodies disinterred, but which, for want of due formality, was not complied with, Lüdowica, in fact, being outside the circle of Alt Sandec, to which M. Zankel was attached, and we not having with us a *special* order from the President to the authorities of the circle we were now in for the disinterment.

The slaughtering had swept away all the animals in the village which were known to have been exposed to the infectious influence of the disease, and consequently we pressed forward through the mountain passes, which here chiefly consisted of the partially-dried beds of rivers and streams, to another village called Żabrzez. It was somewhat singular that at Zabrzez we came upon the identical farm where the malady had first shown itself in this locality, and saw on the premises four of the original Steppe oxen by which it had been brought. Three of these had been the subjects of the disease, but had recovered, and the fourth had resisted the contagion throughout, as was believed, because he had before been affected. They were tied up to fatten, and had every appearance of perfect health, having no trace of disease of any kind about them. Besides these, there were nine other animals on the farm in quarantine, consisting of three oxen, a young bull, and five cows. They also were feeding, and looking well. Twelve days had elapsed since the occurrence of the last death; and we learned that, should no other case happen, the animals would not be liberated until the completion of the twenty-first day from the time of the last death.

Leaving Żabrzez, we went on to Kamienica, five miles distant, and the head-quarters of the Austrian commission, which had been specially sent to administer the sanitary laws applicable to the rinderpest. The commission was constituted of Dr. Anton Karger and M. Johann Rucki, "Imperial Royal Commissioners of Sanitary Police for Epizootics ;" and from them, during our entire stay, we not only experienced all the assistance in their power in furtherance of our inquiry, but likewise the greatest kindness and friendship. We were thus left free to pass as often as occasion required between Kamienica and Zabrzez, and so to act in our investigations, both within and without the *cordon*, as scarcely could be anticipated, when the austerity of military discipline in these cases is considered, and which compensated in a great measure for our oat-straw beds and sour rye-bread repasts.

In Kamienica we found two quarantine stations, in one of which

seven animals were placed, and in the other nine. Two days prior to our arrival a case had occurred in the first station, and more were daily looked for. The animal in question, a cow, was observed by her owner, late in the evening of Thursday, April 30th, to be out of health. She was reported early on the following morning, and immediately seen by the Commissioners, who at once recognised the pest. She lived till 2 P.M. on Saturday, May 2nd, only surviving the attack about forty-two hours. After the body had been examined—which has to be done in every instance—it was buried. The skin, however, was allowed to be removed for the owner's use, subsequent to its being disinfected and prepared under the inspection of the proper officers.

At our first visit to these quarantine stations, in company with the Commissioners and Professor Nicklas, which was late in the afterpart of Monday, May 4th, no indications of disease could be detected in any of the animals—a fact not without some value, as, on our second visit, at 6 A.M. of the following day, an aged cow, one of the seven, exhibited some of the premonitory symptoms of the pest. This case will hereafter be referred to. See page 253.

According to arrangement, we next proceeded to exhume the animal which had died on Saturday, that we might note for ourselves the several lesions which had been produced by the disease. We found that all the viscera of the chest and abdomen had been removed, and were lying by the side of the body; and on bringing both these and the carcase to the surface, we were forcibly struck by the circumstance that so little decomposition had taken place, that no unpleasant smell attended our operations, although the animal had been dead about 65 hours. The flesh also was firm, and of a normal colour, but the blood was still fluid in the vessels, and of a darker hue than natural. It will not be necessary, however, to give a detailed account of the morbid appearances which were met with in the different organs, as, in the course of this Report, we shall have to describe the lesions *in extenso*, as they were observed in other cases; suffice it therefore to say, that although they left no doubt of the animal having died from the rinderpest, they opened up new ideas in our minds as to the pathology of the disease.

Before proceeding to a description of the nature and symptoms of the malady, or the relation of individual cases of it, we propose to give in the next place the

History of the Appearance of the Rinderpest in Zabrzez and Kamienica.

Until the present occasion, the villages of Zabrzez and Kamienica, as well as all the surrounding district, have been perfectly

free from the disease since 1846. The present outbreak took place in the month of March, and was due to the introduction of 10 steppe oxen which had been purchased at a cattle-fair held at Jaczmirz, in the Lemberg division of Galicia.

These oxen came with large droves from Bessarabia, and from three to four thousand head were brought together at the fair. Jaczmirz is about twenty German miles from Zabrzez, and three full days were occupied in driving the animals to the latter-named place. They were bought by M. Berl Krumholz, farmer and distiller, and arrived at the farm on the 15th of the same month, and, after remaining a few hours, were sent on to Kamienica, where the distillery is situated. They were here put with 14 fat oxen, but, in consequence of these being sold for slaughtering two days afterwards, the steppe cattle were returned to Zabrzez on the 18th. Here they were placed in a stable by themselves, and stood there until the 20th, when four of them were a second time sent to Kamienica, with 10 head of young stock, and on their arrival were placed with 21 others. On the following day, the 21st, the six steppe oxen left at Zabrzez were observed to be trembling, which being supposed to depend on exposure to cold, they were put into a shed for warmth, in which were 18 other animals, consisting of some young bulls, cows, and two calves. On the 22nd, the four steppe oxen at Kamienica were likewise noticed to be unwell, and trembling, and, the true nature of their illness being now suspected, they were immediately removed from the other stock, and orders were sent to Zabrzez for the six to be also taken away and kept by themselves.

As a further security to the stock at Kamienica, early the next morning the four steppe cattle were sent back to the farm at Zabrzez. Notwithstanding this precaution, the disease broke out among the young stock on the 30th, and eight of them died on the first day; and by April 3rd thirty-one in all were dead. Besides these animals, M. Berl Krumholz had ten others at Kamienica, and the Commissioners decided upon killing them at once, so that he might receive something towards his loss. The entire number therefore lost by him at Kamienica was 41 animals, and had it not been for the selling of the 14 fat oxen, they also in all probability would have been sacrificed.

On the same day that the disease manifested itself at Kamienica it also broke out at Zabrzez among the eighteen with which the steppe oxen were placed on the 21st. Of the entire 28 animals located here, including the 10 steppe cattle, thirteen died, eleven were killed, three recovered, and one resisted the infection entirely. The three animals which recovered and the one which

escaped the attack were all steppe oxen; they have been previously mentioned as being seen by us on our first visit to the farm. The establishment of the *cordon* confined the disease entirely to this farm, although there were in the village altogether 453 head of cattle, the greater part of which were very poor weak animals, badly fed and badly provided for.

The progress of the disease was rather singular at Zabrzez: thus, 11 of the 13 deaths had occurred by the end of the third day of the outbreak; every one of the animals dying which up to that time had shown symptoms of the disease. On the ninth day subsequent to the death of these another animal sickened and died, and on the fourteenth day after its attack a second; while in twelve days more a third was taken ill, namely, a young bull, whose case will be hereafter recorded in full as coming under our own immediate investigation. See page 256.

Notwithstanding that the same sanitary measures were taken at Kamienica as at Zabrzez, the disease reached the village cattle, but was fortunately prevented making much havoc among them. The ultimate result of the outbreak was, that out of 433 cattle kept in the village, 65 were attacked, of which 37 died, and 28 were slaughtered.

In Kamienica the malady chiefly prevailed among the cattle of the small proprietors and peasants, and the daily lamentations of the poor women, to whom was confided the principal care, or rather on whom was forced the labour of nursing and feeding the animals, at the losses they were sustaining, was most distressing to witness. Nearly the entire means of living of these small farmers depends on the well-being of their cattle, and to see them swept away by such a fatal scourge could not fail to excite our deepest sympathy. A gloom was cast over the whole village, and fear seemed to be depicted on every countenance lest the disease should still further extend itself.

As a warning to surrounding places, notice-boards were erected at the different entrances into the village, setting forth, by their Polish and German inscriptions of "ZARAZA NA BYDŁO ROGATE" and "HORNVIEH SEUCHE," that the pest was there, while each fresh place of outbreak was instantly surrounded by the military *cordon*, and all communication effectually cut off.

Besides Zabrzez and Kamienica, two other adjacent villages in the circle of Kroscienko were the seat of the pest, namely, Tilka and Szczawnica. The total number of cattle kept in the former was 78, out of which 11 were attacked, and of these 10 died and one was slaughtered. In the latter place 490 were kept, and 34 became the subjects of the malady, and of these 25 died, four were slaughtered, and five recovered. It has been

ascertained that the outbreak also in these instances depended upon the introduction of six steppe cattle bought at the same fair.

Characters of the Disease.

Infection.—Rinderpest properly belongs to that class of diseases which are denominated special or specific; by which we understand that there is either some certain and particular cause which gives origin to them, or that a marked peculiarity attends their progress and results. Affections of this kind most frequently possess the power of extension by an inherent property of disseminating the *materies morbi* upon which they themselves depend, and which we recognise by the terms infection and contagion. Thus each victim may be viewed as adding new seeds to the malady by the exhalations arising from its own body; it being a remarkable circumstance that when the morbific matter has entered the system, it multiplies to an inconceivable extent before it is cast out by the organic functions. The circumstance of animals when in health contracting a disease of the same description as that affecting others with which they are located is the best proof of the infectious or contagious nature of the malady. The escape of some under the same circumstances may be due to a variety of causes, and offers no satisfactory proof that the disease is *non*-contagious. For example, all animals are not equally susceptible of being acted on at the same time by the morbific matter; some may, therefore, resist its influence to-day, but in the course of a few days afterwards be susceptible of its action.

The facts which have been given with reference to the various outbreaks of the rinderpest do not require the addition of scientific deductions to establish more firmly the infectious nature of the malady. We believe that it stands second to none in its capability of spreading from animal to animal, *the cattle tribe being alone its victims.* If the malady were one that owed its extension to unexplained causes; if it suddenly showed itself in one part of the Continent, and rapidly spread, despite all precautionary measures and without the introduction of diseased animals, to others near to or at a greater distance from its origin; if, in short, it possessed all the characters of an epizootic; then we might have some reason to doubt its infectious nature.

It has been stated on indisputable authority that any animal which has been exposed to the infection can propagate the disease without itself becoming affected; and that even cattle can do this before they are so, in consequence of the *materies morbi* being lodged in the hair which covers their bodies. This is

by no means improbable, and the opinion receives support from the circumstance that in numberless instances persons visiting the sick cattle have conveyed the pest to other animals of the ox tribe. Thus we see that in these particulars the disease agrees with the small-pox of sheep, or with the plague, small-pox, &c., of man, and that it is as infectious among cattle as the latter-named diseases are among ourselves.

There have been doubters of the infectious nature of the rinderpest, and whenever speculation has been allowed to take the place of facts, although it may seemingly have had science as its basis, great injury has resulted to those most interested in the question. A notable instance of this kind has been furnished us by Professor Renault, Director of the Alfort Veterinary School, and through his kindness we are enabled to transcribe the following particulars.

"Towards the end of 1844 the rinderpest, which had prevailed among the cattle in Galicia, passed through Moravia and made its appearance in Bohemia, in the circle of Königgrätz. The malady had already made some progress in the district, when M. Werner, chief of the Veterinary Department of Bohemia, was sent from Prague by the government to inquire into the precise nature of the affection. This gentleman, who had had many opportunities of seeing the rinderpest, had no difficulty in recognising this disease in the malady in question, and, with a view to arrest its further progress, he recommended to the superior authorities the adoption of those measures which experience had shown to be best calculated not only for this, but to cause its quick extermination: namely, to slaughter the sick animals, isolate those which had been exposed to the contagion, and establish a *cordon* around the infected places. These measures were put in force at once, and soon had the effect of arresting the further progress of the malady, when some young physicians, who had had an opportunity of making for their instruction some *post mortem* examinations of the cattle, thought that they recognised in the affection an analogy to that of the *typhus abdominalis* of man. They, therefore, communicated their opinion to some members of the faculty of medicine at Prague, who, after making several autopsies, came to the same conclusion. A report was accordingly sent to the government setting forth that the malady was not contagious, that it could arise spontaneously amongst the horned cattle of the country, by other influences than those of contagion, and that the means which the government had adopted were not only useless but vexatious. As the faculty had great authority in all sanitary matters, the government, although it did not entirely remove

the restrictive measures, still did not enforce them with its usual rigour; the result of which was that in a few weeks the malady had extended into several other circles of the kingdom, committing such dreadful ravages, that the Austrian government took alarm, and forthwith sent M. Eckel, Director of the Imperial Veterinary Institute, into Bohemia. He at once found that it was the rinderpest, and recommended the rigorous enforcement of the former measures, the result of which was that in six weeks to two months afterwards the malady had entirely disappeared in the kingdom of Bohemia."

Incubation.—Like small-pox, and many other affections common to man and animals, rinderpest lies dormant for a time after the infection has entered the organism. This period is found to vary in different diseases, and also in the same disease at different times, as well as with animals which belong to different zoological classes. It is influenced by many external circumstances, such as the manner in which the infection is received, the heat of the weather, temperament of the animal, freedom from other diseases, peculiarity of constitution, &c. None of these causes can be said, however, to prevent the outbreak of the malady, although some of them may retard and others facilitate its appearance. During the incubative period the animal gives no indication of ill health, and only does so when the disease is about to declare itself.

The time that the poison of rinderpest lies dormant is also found to vary; many animals sickening on the seventh day after exposure, and others not until the thirteenth or fourteenth. Some are said even to pass to the twentieth day before giving evidence of the malady. Such cases are few and may possibly depend on secondary exposure to the infection rather than on so great a variation in the periods of incubation. These secondary exposures are not unfrequently entirely overlooked, and especially with such an affection as the rinderpest, the infecting materials of which can be conveyed by indirect as well as by direct means. It must not be forgotten also that it is a rule or law belonging to this class of maladies, that if an animal passes over the usual period of incubation it is secure against an attack, and in order to become the victim of the affection, it must be a second time exposed to the influence of the morbific matter. Direct and well considered experiments are wanting with regard to the incubation of the pest, and these we had no opportunity of making while on our mission. No doubt, however, should be allowed to remain on a point like this, as on it depends the security to be afforded to every country which is contiguous to the steppes of Russia. Austria, which suffers almost annually from this disease in some parts of her dominions, has an especial interest in the question,

and should lose no time in effecting its complete and satisfactory solution. In our opinion Austria should appoint a commission of scientific men, and vest it with some of her absolute power to conduct experiments and take every necessary means of determining the point in a conclusive manner, for the benefit of other countries as well as herself, and she will then both deserve and receive the thanks of the world.

Spontaneous Origin.—The steppes of Russia are the home of the rinderpest, and here it may be said to hold almost undisputed sway, little being done by the Imperial government to stay its ravages. Here also, as has been elsewhere stated, it is alone regarded as having a *spontaneous* origin, but with what amount of correctness we are unable to say. Doubtless every disease has had its place of origin, and in it there may exist persistent causes which keep alive, so to speak, the curse of sin. Such causes may possibly be found on these vast plains of Russia, and if so, here would be the natural habitation of the pest. Be this as it may, it is certain that in those countries which are contiguous to the steppes, the malady has no such origin, and its appearance in them is invariably associated with the recent introduction of steppe cattle and generally in the ordinary course of traffic.

No disease, which we have ever studied, appears to be governed by such precise laws as this with regard to the means of its extension; and it is difficult to believe that it should spread by infection alone throughout Europe, and not be subject to the same law in the steppes. Supposing the fact, however, to be as asserted, it is evident that peculiarity of breed is not the cause on which it depends. Large numbers of steppe oxen are met with out of Russia, and in Galicia we saw many which were used for the purposes of husbandry, and these are never known to be the subjects of the pest, unless brought under the influence of the infection. Besides, the Hungarian, Italian and steppe cattle are all, from their great similarity, evident descendants of the old Roman ox, and yet it appears that in but one of these has rinderpest a spontaneous origin. Hungarian oxen are even said to be less susceptible to the disease than the other breeds met with in the Austrian dominions, and to bear up better against it, so that the per centage of deaths among them is much less than among others. Exertion has been assigned as the cause of the appearance of the malady, but like breed this seems to be powerless with all cattle except those of the steppes. We do not regard, therefore, the fact of the breaking out of the pest among steppe cattle at the end of a journey as a satisfactory proof that the exertion they have undergone is the cause.

When we observe a malady to be capable of being communicated from animal to animal by innumerable means of

conveying the *materies morbi*, and when we take into account the varying susceptibility of animals to the immediate action of this matter, and also the further circumstance of its remaining dormant in the system for a fortnight, or possibly a longer time, we see many reasons for withholding our assent, without greater experience in the disease, to the opinion that the pest has a spontaneous origin in the ox of the steppes.

General Symptoms of the Pest.—When the animal sickens, the affection will be recognised by almost continuous spasmodic twitchings of the voluntary muscles of the body, more particularly those of the neck and shoulders, and of the hind quarters. These twitchings are accompanied by tremors which are more or less generally diffused, and which interrupt the regularity of the spasms, and give to the animal an appearance of suffering from exposure to cold. The coat stares, and the patient stands with its back arched and its legs gathered together under the body, but does not seemingly suffer much acute pain. In the course of a few hours rumination is suspended, and the appetite fails, but water will generally be partaken of almost up to the end.

The temperature of the body is variable, a slightly increased warmth of skin existing at the beginning of the illness, which soon, however, gives way to a chilliness of the surface, and this again to a death-like coldness of the ears, legs, and horns, as the malady advances to a fatal termination. The pulse is scarcely disturbed at first, unless the attack is a severe one, when it quickly rises to 70 or more, but wants tone in its action. In all ordinary cases it becomes gradually more frequent in number, but less in force, and in the latter stages can only be felt at the heart.

The respiration is but very little altered at the commencement; it rarely becomes difficult, and was never painful in any of the cases we witnessed. It sometimes rises to 30 on the second day. The contractions of the abdominal muscles are often interrupted in their rhythmical action by the spasmodic twitchings which give a singular motion to the animal's flanks, and has led some observers to speak of a difficulty of breathing as being invariably present. A discharge comes on early from the nostrils, which has many of the characters of ordinary mucus, but, when carefully examined, will be found to contain flocculi of lymph. A slight cough is also present in some cases, but it cannot be heard except one is near to the patient, when it imparts a singular and almost indescribable sound to the ear.

The expression of the countenance does not denote much acute suffering, and the eyes are without any dull appearance except in the advanced stages of the malady, when the lids are found to be drooping as in sleep, and the ears also to be a little

lopped. The vessels of the conjunctival membrane are almost without turgescence, but a discharge in most cases comes from the eyes, which accumulates in a yellow jelly-like mass at the inner angle, and when examined it likewise is found to be composed principally of lymph.

The bowels are but little disturbed at the very beginning of the disease, but the feculent matter, almost unaltered at first in consistency, is soon passed in increased quantity, and in the course of the second day diarrhœa sets in. This diarrhœa is presently followed by dysentery, which continues to the end. The evacuations are not particularly offensive, but they are remarkably fluid, of a dirty yellow colour, and mixed with numerous small flocculi of lymph. Occasionally a little blood stains the evacuations, and tenesmus is also present in some cases. The abdomen becomes much pinched in, and the animal's strength quickly fails him. He now keeps mostly recumbent, and rises very reluctantly. If made to move he staggers, and often falls for want of strength. The spasmodic twitchings *now begin to diminish*, and for some hours before death they have entirely passed off.

A sickly smell attends the patient, but there are no disengagements of gaseous compounds into the areolar tissue, nor any other indications of the decomposition of the tissues which have been spoken of by some writers. In short, the animal dies, apparently, and almost without convulsions, from pure prostration of the vital powers.

In those cases which recover no pustules have been observed as forming on the skin, nor any desquamation of the cuticle or fall of the hair. Nor have any ulcers of the eyes, nostrils, or muzzle been noticed in either extreme or protracted cases.

One of the most favourable indications of a return to health is a less frequent evacuation of fluid from the intestinal canal, and the dejections possessing somewhat a feculent character. Such animals soon acquire a more lively appearance, look about for some tempting kind of food, and will slowly begin to ruminate. The pulse acquires more tone, the temperature of the body rises, and the respiration becomes natural, but the diarrhœa will not unfrequently continue for seven or eight days.

Duration.—In all cases which tend to a fatal termination, the animals rarely live beyond the fourth day after the symptoms have shown themselves, while very many of them will sink as early as the second day. The greater number, however, die on the third day from the attack. In those which recover, some diminution in the severity of the symptoms usually takes place on the third or fourth day, and if the patient survives this time, even should the symptoms not abate, it is regarded as a favourable indication of ultimate recovery. The return to perfect health

is rarely effected in less than three weeks, but much will depend on the age and constitution of the animal, as likewise on the amount of structural disease in the mucous membranes of the alimentary canal, and not a little also on the care and attention which are bestowed upon the patient.

Percentage of Deaths.—If the pest be allowed to take its natural course for only a few days, it will be found that the deaths not unfrequently number 90 *per cent.* Steppe cattle are, however, said to bear up better against the affection than others, so that about one-half of them will sometimes recover. Speaking, however, in general terms of the different breeds of cattle, as well as of the different circumstances under which they are placed, the mortality will be found throughout Europe to range from 75 to 80 per cent. Fat animals and those which are well cared for, are found to bear up very badly against the disease.

Post-mortem Appearances.—The morbid lesions produced by the pest will be found centered in the mucous membranes, which are more or less affected throughout the entire body. Commencing an examination at the mouth, it not unfrequently happens that many of the conical papillæ which stud the body of the tongue will show, here and there at their bases, their vascular and epithelial coverings to be broken up by the ulcerative process. The root of the tongue, fauces, and *velum palati*, are also similarly implicated to a greater or less extent, while their follicles are filled with effused lymph, giving to the parts an appearance as if dotted over with some yellow pigment. Some of the follicles are likewise ulcerated, but the major portion are merely distended with lymph.

The tonsils are in a similar condition; and when a section is carried through their long diameter, large portions of lymph can be drawn from their ducts, the yellow colour of which, interspersed in lines along the course of these passages, contrasts strongly with the red substance of the organs. Much turgescence of the vessels of the Schneiderian membrane, with points of ulceration and shreds of lymph are met with, more particularly about the posterior nasal opening, and base of the vomer. These lesions, however, rarely extend beyond the middle portion of the *septum nasi.*

The pharynx presents the same appearance, but the œsophagus is healthy, as is both the rumen and reticulum in most cases. In some few instances the epithelium readily peels from off the inner surface of these stomachs, when the vessels beneath are found to be turgid with blood. The rumen invariably contains a fair quantity of ingesta in the state usually met with in healthy animals. The omasum is without structural change, or at most its mucous surface presents an analogous condition to that of the

rumen and reticulum. The contents of the omasum are frequently so dry and hard that they can be rubbed to powder between the fingers. This has been considered by many continental pathologists as a peculiarity attaching to this disease, and hence the term *Löser dürre* has been given to the malady. In three consecutive *post mortem* examinations, as well as in many others, we found that no alteration either of the omasum or of its contents existed which was incompatible with perfect health.

The mucous membrane of the abomasum is always highly congested, more especially towards the pylorus; and its follicles are in an analogous state to those of the fauces, *velum*, &c. The duodenum, jejunum, and ileum are similarly affected, but to a greater extent. These intestines often present a bluish aspect on their serous surface, which is entirely due to the turgescence of the vessels of the mucous membrane; this being seen through the other coats, gives a greater depth of colour to it than natural. Peyer's glands are not invariably diseased, but, like other follicular openings of the digestive canal, they are often covered with layers of lymph, beneath which ulceration is occasionally observed, but more frequently the surface is healthy, although turgid with blood.

The chief ravages of the disease as we have met with them are in the large intestines. The blind end of the colon—the cœcum—was, in one case in particular, ulcerated over several inches of its inner surface, that is, numerous small and distinct ulcers existed, which had evidently had their origin in the follicles of the mucous coat. Thin deposits of lymph, varying in size from that of a pea to the end of the finger—scabs as they have been designated—usually stud the large intestines almost throughout their whole extent. They are of a dirty yellow colour, and adhere with tolerable firmness to the mucous membrane beneath. In some places ulceration is found to be going on in the membrane; in others this destructive process has ceased and the healing one commenced, and in most no change in structure can be observed. The terminal portion of the rectum is generally implicated to a far less extent.

The substance of the liver is healthy; the gall-ducts, however, contain layers of effused lymph; and sometimes to an amount sufficient to block up their passages. The gall-bladder is filled with bile possessing its ordinary characters, but the inner surface of the bladder is not unfrequently in precisely the same state as the mucous membrane of the large intestines.

The kidneys are healthy, and the urinary and generative systems apparently unaffected.

The larynx is occasionally slightly ulcerated, particularly on

the edge of the arytænoid cartilages. No ulceration, however, has been seen by us throughout the whole extent of the windpipe and bronchial tubes; but thin layers of effused lymph lying in close contact with the mucous are almost invariably present. The lungs are healthy, of a normal colour, and often remarkably free from congestion. Their serous membrane is also unaffected.

The heart is healthy, occasionally rather flaccid, and without blood in its cavities. The blood in all the vessels is *fluid*, evidently from loss of its fibrine. It is also darker in colour than ordinary *venous* blood. The brain and spinal marrow give no evidence of structural change; but an increased quantity of fluid is often found in the ventricles of the brain, and especially in the upper part of the *theca vertebralis*. The flesh is firm, of a good colour, and has but little tendency to pass quickly into decomposition; indeed we have not unfrequently seen it in a state fitted for food.

Pathology.—It is difficult to speak with certainty of the true nature of the rinderpest, but it is evident that the morbific matter on which it depends, having entered the system through the medium of the organs of respiration, soon acts upon the blood, by converting some of the constituents of that fluid into its own elements; and that, while this process is going on, the animal gives no recognisable indications of being the subject of the malady. This period constitutes the incubative stage of the disease. The blood, having thus become contaminated, its vitality impaired, and the poison augmented a thousand-fold within the organism, the brain and nervous systems, as the centres of sensation and motion, have their normal functions necessarily and quickly interfered with, and hence one of the earliest indications of the disease is a spasmodic twitching of the voluntary and other muscles of the body.

The malady has now arrived at a stage when nature makes a bold effort to rid the system of the poison, and in doing this the force of the morbific matter, so to speak, falls with more or less severity upon the mucous membranes throughout the entire body. Effusions of lymph—the fibrine of the blood—take place into the follicles of the mucous membranes, as an effect perhaps in part of the overtaxing of these grand excretory organs, and partly because the fibrine itself is charged with the *materies morbi*, and has probably also lost some portion of its vitality, which renders it unfitted to remain in the vessels. Dark-coloured blood, which remains fluid even after death from its defibrination, now flows in the vessels; and dysenteric purging also sets in, under which, as a rule, the animal quickly sinks.

If, on the contrary, the *vis vitæ* should be sufficiently powerful to withstand so great an exhausting process, then the poison

being cast off, and principally by the digestive canal, the patient slowly rallies, and the functions of the organism are gradually restored. Healthy fibrine again supplies the place of that which was lost, so that the blood will now clot when removed from the vessels, and be once more brought into a state to support the vitality of the prostrated organs. Ulceration of the mucous membranes, commencing in the follicles, may attend these processes, but it is not a necessary pathological condition of the pest. It is rather to be regarded as a sequence depending for its existence on the amount of the contamination of the blood, the duration of the disease, and the diminished strength of the vital forces. In all this we have a great similarity to the pathology of the small-pox, but in that disease the external skin is the principal focus of the malady; while in rinderpest the mucous membranes or internal skin are its chief seat. Small-pox frequently proves fatal before the local symptoms are well established, and so indeed does rinderpest from the great amount of morbific matter with which the system is charged.

Names given to the disease.—Of all the terms which have been given to this malady, there is none which we are willing to adopt in preference to "RINDERPEST." It is the one which we have employed throughout this Report, although it may be thought that it is too general in its application and deficient also in explicitness to be selected in preference to others which set forth something of the nature of the disease. The term nevertheless explains that the affection is a true *cattle plague;* and, besides this, being the one which is used throughout Germany, it is thoroughly understood in nearly every European state—a fact which gives it a value above many others.

"STEPPE MURRAIN," although it tends to throw some light on the chief location of the disease, fails to take cognizance even of the kind of animal which is the subject of it, and leaves the pathology entirely unexplained.

"CONTAGIOUS TYPHUS" is far from being appropriate, notwithstanding that the disease has some characters which are common to the typhus of man. The differences which are observed in the duration, progress, symptoms, and results of the two maladies, are far too numerous and important to warrant the pathologist in the adoption of a *definite* term of this kind, and for this reason we have abstained from employing it.

"LÖSER DÜRRE" is in our opinion the most inappropriate of any of the names we have alluded to. The hardness of the third stomach, or rather of its contents, which the term implies, is not a speciality attaching to the affection. It may often be present, but it is just as frequently absent. The term directs attention to one particular part of the body as the seat of diseased action, and con-

sequently it often leads to incorrect conclusions. We have seen men of ability, who have been called upon to make *post-mortem* examinations, hesitate to pronounce a decided opinion of the existence of the pest when the third stomach has been found healthy. Hardness or dryness of these contents is common in twenty other diseases of cattle, and in nearly every instance in which it occurs it is but an effect of suspended function of the third stomach, as the cessation of rumination is of the first.

Treatment.—We have very little to report of a satisfactory nature of the medical treatment of the rinderpest. Indeed, no attempts at curing the disease are now made, in consequence of the inutility of all the means which have been tried, and the greater risk which is incurred of a still further extension of the malady by the keeping alive of animals which would otherwise be slaughtered at once. The advancement which has of late years attached to the science of medicine would seem to hold out a hope that remedies may be found for this hitherto incurable disease. All experiments, however, undertaken for this object, would have, we believe, but little chance of success, unless they were carried out by, or under the immediate superintendence of, the professors of the different veterinary institutions of those countries in which the pest prevails.

No definite plan of treatment can be laid down, except it is that of supporting the fleeting vital powers while nature is attempting to rid the system of the poison, and then to endeavour to counteract the ill effects which had resulted. Remedies calculated to promote this end must however be selected for each particular case, and also be suited to each particular stage of the malady.

With these few observations on this part of our Report we shall proceed to give the details in full of several cases of the disease which came under our immediate notice.

Case I.

At page 240, mention has been made of an aged cow, which was observed, on our second visit to the quarantine stations on May 5th, to be out of health, the symptoms indicating that she was the subject of the malady.

Considering the great fatality and the usually rapid progress of the rinderpest, it is somewhat surprising that its victims should so frequently show such little disturbance to their health at the commencement of the attack. The animal in question was a remarkable instance of this, as well as of the occasional mild character of the disease. The chief indications of illness which she exhibited, when first seen, were tremors of most of the

voluntary muscles of the body, but more especially those of the extremities. The *triceps* muscles of the fore-limbs, and the *glutei*, *vasti*, and *triceps* in particular of the hind-limbs, were most affected with these tremblings; besides which a spasmodic jerking of their fasciculi could be detected as coming on at irregular and short intervals. The animal stood with her back arched and legs gathered together under the body. The head was extended, ears lopped, and coat staring. She was remarkably dull, and greatly indisposed to move. Her appetite was impaired, but not lost, as at times she would pick a little fresh grass. Rumination was tardily performed; the action of the bowels unaffected: the breathing natural, and the pulse almost undisturbed. Indeed, had the morning been a cold one—which it was not—nearly the whole of the symptoms that she exhibited might have been ascribed to an exposure to the bleak mountain air.

Towards the after-part of the day the spasmodic contractions of the muscles were more diffuse. The jerking of those situated at the infero-lateral part of the neck was very peculiar, imparting a movement not very dissimilar to the so-called venous pulse. The skin was rather warmer than natural, but the coat was staring, as in the morning. The breathing still continued undisturbed, while a slight but "thick cough" was occasionally heard. The pulse had risen to about 62. It was regular in its action, but beat with somewhat diminished force. There was no injection of the visible mucous membranes present, nor dryness of the muzzle, as seen in active febrile diseases. The Commissioners expressed their decided opinion that this was a true case of the pest, although an unusually mild one, and they therefore gave orders that the cow should be taken from the others, and placed in a separate shed, temporarily erected with the branches of pine trees for the purpose, so that we might watch its progress.

May 6th, 7 A.M.—The symptoms upon the whole have undergone but little change since last evening. The animal still takes a little food, but is equally as dull and dispirited. She shows a disposition to drink freely of water, and would take even more than it is desirable to give her.

8 P.M.—No alteration of importance.

May 7th, 6 A.M.—A change for the worse has come on during the night. The prostration of strength is considerable, and the animal is down, unable to rise. Neither the pulse nor the breathing have, however, undergone much change, the principal being that the action of the heart is rather weaker. She refuses food. Rumination is suspended, and the bowels are rather irritable, voiding large quantities of fæces. The twitchings of the muscles are yet present, but mostly confined to the shoulders

and neck. The cough is more frequent, and a little mucous discharge also comes from the nostrils. The conjunctiva is uninjected, but the eyes are somewhat intolerant of light. The general surface of the body is chilly, as are the legs, ears, and horns.

On visiting the animal in the evening, we found that a slight diarrhœa had set in during the day; that the pulse had risen to 70, and that increasing weakness was existing. There were, however, but few indications that the attack would terminate fatally, the other symptoms remaining about the same.

May 8th.—The twitchings of the muscles are scarcely to be observed this morning, as is generally the case in the advanced stages of the malady. The diarrhœa is, however, more copious, but yet not alarming; the pulse is quicker and weaker, and only to be felt at the heart. The breathing has now become somewhat increased, but is neither laboured nor difficult. The body is cold, and the animal lies with a drooping head and closed eyes, as in a state of drowsiness, refusing all food, but showing the same disposition to take water.

The Commissioners explained that they considered there was no chance of the animal's ultimate recovery, although the case would doubtless be a very protracted one. They also said that they had decided to have her killed in the after-part of the day, if we had seen enough of the disease in its mitigated form, that we might institute a *post-mortem* examination. This arrangement met with our concurrence, and especially as other cases had occurred since this cow was attacked, and which we were busily engaged in watching the progress of, as by it an opportunity would be afforded of seeing the lesions which were early produced by the malady.

SECTIO CADAVERIS.—*Respiratory Organs.*—Mucous membrane of the nasal cavities slightly congested, and covered in patches by a small quantity of a yellowish and somewhat viscid discharge. Larynx healthy; trachea nearly free from injection, but containing some thin shreds of colourless lymph lying in close contact with its lining membrane. Bronchia healthy; lungs perfectly healthy. No effusion into the thorax.

Circulating Organs.—Heart and its vessels healthy. Blood, dark in colour and but partially coagulated; the coagulum being very soft.

Digestive Organs.—Tongue healthy; fauces and velum congested; pharynx and œsophagus, healthy. Rumen healthy, containing a fair amount of ingesta. Reticulum and omasum likewise free from structural disease, and no hardness of the contents of the omasum (löser dürre). Slight efflorescence of the mucous membrane of the abomasum in patches was present, while nearly throughout it was likewise dotted over with yellowish points,

produced by effusions of lymph into its follicles. The contents of this stomach were fluid, in which floated some shreds of lymph. The duodenum, jejunum, and ileum were nearly free from disease, presenting only here and there a similar state of the mucous membrane to that of the abomasum. The cœcum, colon, and rectum were filled with fluid fæces, but their mucous membrane was, on the whole, free from change.

Liver, healthy in substance; the gall-ducts were, however, enlarged and thickened in their coats from chronic disease, associated with depositions of osseous matter. The gall-bladder was filled with bile, and its mucous membrane was likewise studded with effusions of lymph into its follicles analogous to the abomasum.

Pancreas and Spleen.—Healthy.

Urinary System.—Kidneys, bladder, &c., free from disease.

Nervous System.—Brain, spinal marrow, and their membranes healthy, in so far as their structural appearance was concerned.

Case II.

May 6th.—After giving our attention this morning to Case I., we went over to Zabrzez to inspect the cattle which we saw at M. Berl Krumholz's farm at the time of our first visit. Here we found that a young bull, two years and a half old, and one of the nine animals referred to at page 239, as still being in quarantine, was the subject of the malady. The animal in question had only been observed to be unwell early this morning, being twelve days subsequent to the death of the last victim. The symptoms now present were spasmodic twitchings of the muscles, more particularly of those of the neck and shoulders. The spasms succeeded each other with great irregularity, but numbered on the average about ten in the minute. They were likewise accompanied with slight shiverings of the entire body. The skin was warm, as were also the legs, horns, and ears. The back was arched and the animal stood with his legs gathered under the body, but frequently shifted his position as if in pain. His countenance, however, was more animated than is generally seen, even in the early stages of the malady. There was a little turgescence of the vessels of the conjunctiva, but no intolerance of light. A slight mucous discharge flowed from the nostrils, and a short, but nearly inaudible cough was present. The breath was sweet, and the respiration scarcely disturbed. The pulse was increased to 80, and had more fullness than is usual in these cases. All desire for food had ceased; rumination was suspended, and the bowels were in a relaxed condition.

6 P.M.—The symptoms are somewhat aggravated. The animal

is down and is more depressed than in the early part of the day. Diarrhœa has set in and some tenesmus is present. The twitchings of the muscles are more violent and frequent. The cough is increased, as is the discharge from the nostrils; the pulse, however, remains the same.

May 7th.—There is no great change in the general character of the symptoms this morning. The diarrhœa is, however, more copious. The pulse is weaker, but its number is not increased. The breathing is but little altered. The cough is of the same mucous character. The nasal discharge is thicker and contains shreds of lymph. The eyes are heavy. The animal keeps laid a good deal, and when down appears sleepy. The spasmodic contractions of the abdominal muscles, which at times are considerable, give a peculiar tremor to the whole body and interrupt the rhythmical action of inspiration and expiration. Pressure on the spine augments these spasms as well as those of the muscles of the neck and limbs. He refuses all food, but takes a little water.

6 P.M.—Except that the animal is weaker and the alvine evacuations more fluid, there is no change which needs to be specially reported.

May 8th.—The spasmodic twitchings are less diffused than yesterday and not so severe. The pulse is, on the contrary, more rapid and so weak as to be felt with very great difficulty except at the heart. The respiration is also increased and now numbers twenty-six in the minute; it is not, however, laboured. The cough although frequent is scarcely audible: it has the same mucous character. The muzzle is moist but cold, as are the extremities and horns; while the surface of the body is yet warm. The diarrhœa has passed into dysentery. The evacuations are now of a dirty-yellow colour, and remarkably fluid; they contain flocculi of lymph and are occasionally streaked with blood, but are not particularly offensive. A sickly smell attends the patient. The eyelids are drooping, and a thick jelly-like mass of a pale straw colour has accumulated at the inner angle of the eyes. This is evidently composed chiefly of fibrine; yet the vessels of the conjunctiva are not turgid with blood. The animal has a greater disposition to keep laid, and often while recumbent turns the head to the side as if suffering slight abdominal pain.

May 9th.—The spasmodic twitchings and the tremors are no longer to be recognized, having entirely passed away. The prostration of strength is very great. The dysenteric purging continues unabated in severity. Tenesmus is present and the evacuations are now very offensive. The abdomen is much pinched in. The respiration remains the same in number, and is occasionally accompanied with a nasal blowing-like sound.

The discharge from both the nostrils and eyes is augmented in quantity; the eyes, however, still retain their transparency and the blood-vessels are but slightly injected. The pulse is not weaker than yesterday, but upon the whole a little more distinct. The ears, horns, and extremities are still a little warm. The animal takes a small quantity of water, and appears to be free from any acute pain.*

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* The Commissioners decided to-day upon slaughtering the remaining eight animals in the quarantine, as two or three of them were giving indications of approaching illness. They also had in view the raising of the *cordon* at an earlier date than it otherwise could be, supposing the malady was allowed to take its ordinary course; for, as elsewhere stated, it has to be maintained for *twenty-one* days after the death or the killing of the last animal. The chief object in keeping up the *cordon* for this length of time is to prevent the possibility of a fresh outbreak. No newly-purchased cattle are therefore allowed to come unto the farm, nor is any labourer, or other person, allowed to leave it. No straw or fodder of any kind is permitted to be removed; in fact, all the details are as rigorously enforced during these three weeks as while the disease exists.

The resolve of the Commissioners afforded us the opportunity of witnessing the form of valuing the cattle *for slaughtering* on the part of Government, their real value being greater than the estimated one. For this purpose a jury of three persons was summoned, consisting of the Burgomaster of the village and two other inhabitants conversant with the worth of cattle. They were not, however, allowed to come within 200 paces of the line of the *cordon*. The non-medical commissioner, M. Rucki, took his seat at a table placed on the line, and being furnished with writing materials, noted every particular of the transaction. The cattle were then brought one by one to within a short distance of the Commissioner, to be inspected by the jury, who asked a great variety of questions relating to their age, breed, and use for feeding, milking, or working purposes; which being satisfactorily answered, they made their award.

			£.	s.
The first, a young heifer, was valued at about, in English money			4	0
The second, also a heifer,	,,	,,	4	0
The third, a milking cow,	,,	,,	7	0
The fourth, a young steer,	,,	,,	3	6
The fifth, an older steer,	,,	,,	4	18
The sixth, a young bull,	,,	,,	4	0
The seventh and eighth, two heifers,	,,	,,	8	16
Total			36	4

The skins of the animals were next valued at 8*s*. each for the larger ones, and 6*s*. the smaller, which sums we were informed would be deducted from the gross amount; the proprietor being allowed to dispose of them as he thought fit after they had undergone a disinfecting process, under the immediate superintendence of the Commissioners. This part of the ceremony being ended, the animals were led away to be slaughtered and buried, when the jury were permitted to approach the table to sign their award. One only of the three could write, namely, the Burgomaster, and he received authority to sign for the others. The appearance of these men was certainly picturesque, if not very prepossessing. They were very scantily clad, having on scarcely any clothes except a long coat made of a coarse and thick woollen material of a dirty-white colour, and reaching to below their knees. The Burgomaster differed but little from his compeers, excepting that he wore a leather girdle, furnished with a pocket, around his waist, in which he carried his money, and of which, little as it was, he appeared very proud. Their legs were enveloped in pieces of linen tied on with string, and their feet were protected by roughly-made sandals, having very thin leather soles, being apparently of their own manufacturing.

May 10th.—The symptoms are somewhat diminished in severity this morning, leading to the hope that the animal may possibly rally. The dysenteric purging is less in quantity, and the evacuations are less frequent. The breathing is more tranquil and the cough more audible. The pulse has sunk to 70, and has an increased tone. Each rising of the artery is accompanied with a peculiar jerking action. The discharge from the nostrils and eyes has not undergone any material change. The extremities and surface of the body are warmer, and the animal evidently is freer from suffering. He lies less; takes freely of water, and shows a little disposition to pick some fresh green-clover, a handful of which we gathered for him.

May 11th.—Scarcely so well to-day. Some blood is occasionally passed with the alvine evacuations. These are still fluid, have a fetid smell, are of a pale colour, and contain numerous shreds of lymph. The abdomen is more pinched in. The pulse is rather quicker, as is the breathing, the expirations being at times accompanied with a slight grunt. The discharge from the eyes and nostrils is less, but the cough is more frequent. He has, however, eaten a little clover and drank some water, and stood up at intervals for a longer time than before.

This change in the symptoms made us most desirous of watching the case to its close, but the Commissioners ordered that the animal should be killed forthwith, as they saw no hope of recovery, and were anxious to remove the *cordon*, there being no cattle left on the premises, except the Steppe oxen, mentioned at p. 239, as having some weeks since recovered from the pest.

Post-mortem Examination.—On removing the skin, the muscles were found of their usual colour and integrity, and the areolar tissue throughout was free from congestion. Commencing the examination of the internal organs at the nostrils, the Schneiderian membrane was observed to be much congested, more particularly that portion of it which is continued into the *posterior nares*, where it was extensively ulcerated. This ulceration could be traced from thence to the free edges of the *velum palati*. In places it was concealed by a thick layer of lymph which adhered with tolerable firmness to the membrane beneath. The larynx, trachea, and bronchi were free from disease, as were also the lungs. The heart was healthy. It contained within its ventricles a small quantity of blood, which was *partially coagulated;* the coagulum being very soft.

The tongue was healthy as was also the pharynx, but the ducts of the tonsils were filled with effused lymph; the surrounding vessels being turgid with blood. The œsophagus, rumen, and reticulum were in a normal condition. The contents of the omasum were rather dry from retention, but no structural change

had taken place in the stomach itself. The mucous membrane of the abomasum was slightly ulcerated in small-sized patches here and there, while nearly throughout its follicles were distended with lymph, more especially towards the pylorus.

The mucous membrane of the small intestines was congested, the bowels themselves containing numerous flocculi of lymph. Several of Peyer's glands were ulcerated. In some, arrestation to this process had taken place and the healing one had begun. All these glands were covered, more or less, with a thickish layer of effused lymph. The mucous membrane of the cœcum was extensively ulcerated at the blind end, and throughout the intestine it was thickly beset with scabs of a dirty-yellow colour. Many of these scabs—the product of lymph effusions—covered surfaces in which no disease could be detected. Other of the scabs had ulceration going on beneath them, while under several the healing process had commenced. They varied in size from that of a small pea to the end of the finger. They were also of different forms and thicknesses.

The colon was in a similar condition to the cœcum, as was likewise the rectum to within a few inches of its termination. These intestines contained no fæces, but were filled with a fluid of a yellowish colour, in which floated many shreds of lymph. The liver was healthy, but the lining membrane of the gall-bladder was in a precisely similar condition to that of the large intestines. The kidneys were pallid but unchanged in structure. The bladder and genital organs were perfectly healthy. The brain and spinal marrow gave no evidence of structural change, but effusion of serous fluid had taken place into the theca-vertebralis.

Case III.

May 7.—The animal, a very poor and weak heifer, was reported by the sentinel on night duty at the quarantine in Kamienica to have been observed early this morning to be giving indications of the disease. The symptoms noticed by us on our visit consisted in chief of spasmodic twitchings of the muscles of the neck and extremities in particular, associated also with general shiverings of the body at irregular intervals; pulse 60, having a sharper beat than natural; a loathing of food; suspension of rumination; grinding teeth; lax and copious fæces; depressed countenance, drooping eyelids, lopped ears; staring coat; arched back, and chilly surface of body; the animal standing with its legs gathered together under the belly. The respiration was, however, undisturbed; the vessels of the conjunctiva uninjected, and the muzzle moist. No tenderness along the course of the spine was evinced on the application of pressure.

At night, with the exception of increased weakness and the passing of more fluid fæcal evacuations, there was no material change in the symptoms.

8th.—The pulse now numbers 65, and has lost its sharp beat; the breathing is a little quickened; the diarrhœa has passed into dysentery; the animal's appearance is very dejected; a discharge flows from the nostrils and eyes; the coat is staring; the spasm of the muscles more intense; the extremities and body are cold; and the prostration of the vital powers very considerable.

9 P.M.—The pulse has risen to 75, and can be felt only with difficulty in the arteries; the breathing has become very much quicker during the day, and now numbers 24 in the minute; the dysentery is profuse; tenesmus is likewise present. The other symptoms remain about the same as in the morning.

9th.—The symptoms are all increased in severity, excepting that the tremors have nearly disappeared; the abdomen is much pinched in; small quantities of blood stain the alvine evacuations, which are likewise very fœtid; the pulse is remarkably tremulous, and the respiration is short and quick. The animal will, however, still take a little water to drink.

10th.—During this day she struggled on against the disease, but sunk about midnight, being far too weak to rise for several hours before death.

Post-mortem,—eight hours after death.—No congestion of the superficial vessels, nor change in the colour of the flesh, was observed on the removal of the skin, and there was but little tendency to decomposition of the body. The blood, however, was *fluid* and of a dark colour in all the large veins. Ulceration had commenced in several places on the dorsum and root of the tongue, especially around the bases of the conical papillæ. The fauces, *velum palati*, pharynx, and larynx, were also ulcerated here and there in patches of about the size of a shilling; the mucous membrane of the posterior nasal opening was intensely reddened and studded with yellowish-coloured points from effusions of lymph into its follicles: the ducts of the tonsils were also filled to completion with lymph. The lining membrane of the windpipe and bronchial tubes was but slightly congested; but in many places it was covered with *layers* of effused lymph. The substance of the lungs was healthy, as was their serous covering. The heart was rather flaccid; no blood was found in its ventricles.

On opening the abdomen some petechial spots were found on the omentum, otherwise the serous membrane was free from any vascular injection. The fourth stomach, and also the small intestines presented a dark-coloured condition of their outer coat, but this was ascertained to depend on the congested state of their

mucous lining as seen through the other coats. The first stomach—rumen—was free from disease, but its epithelial lining could be readily peeled off in places, doubtless from changes which had taken place since death. This stomach contained some rather dry ingesta. A similar state of things was met with in both the reticulum and omasum, but no true *löser-dürre* existed. The lining membrane of the fourth stomach—abomasum—was intensely reddened throughout, and its follicles crammed with lymph. Effusions of lymph adhered in many places, as scabs of a dirty-yellow colour, to the mucous membrane of this stomach.

The duodenum, near to the pylorus, was in a similar state to the fourth stomach, as were the jejunum and ileum in several detached places along their course. Peyer's glands were free from ulceration, and several of them had every appearance of health. The mucous membrane of the large intestines was ulcerated here and there, while in other parts no change of structure could be detected. These intestines contained much mucus mixed with shreds of lymph. The liver was healthy in its substance, and the gall-bladder was filled with a greenish-coloured bile. Its lining membrane was free from disease, but thin bands of lymph could be drawn from out of many of the large biliary ducts. The urinary and genitive organs gave no evidence of disease. The brain and spinal marrow were firm, and presented no structural change, but an unusual quantity of fluid existed both in the ventricles of the brain and also in the upper part of the theca vertebralis.

In consequence of the occurrence of this case, and of Case I. in the same quarantine station, the Commissioners determined to slaughter the rest, consisting of five head of cattle, reserving only the animal in question for our special purposes. This resolve was taken on May 8th, and was somewhat hastened by the circumstance that all the animals were in very low condition and of little value, being the property of small farmers but one degree superior in position to the peasants. The greatest difficulty also existed in procuring sufficient food for the animals; and poor women, the wives of the proprietors, could be daily seen standing in the mountain streams for hours together up to their knees in water, with scarcely clothing sufficient to cover their persons, washing coutch-grass, which had been picked from off the land in order to feed these cattle. The step was, doubtless, rendered necessary by the circumstances; it was nevertheless most painful to witness the lamentations of the poor women on its being carried into execution.

Shortly after the removal and slaughter of the animals the quarantine station was set on fire, and soon razed to the ground.

Case IV.

On the evening of May 9th information was brought to the Commissioners that a fresh outbreak of the malady had occurred in the village of Kamienica. On hearing this we were almost immediately on the spot, and found that a cow, one of five of the herd, was fast *sinking from the disease.* It was evident that she had been ill for at least two or three days, but had not been reported. The Commissioners expressed much dissatisfaction at this, and immediately took possession of all the animals, and sent them off the premises into quarantine. The key of the stable in which the cow had been standing was delivered over to the custody of the military, and the *cordon* established. We may here repeat, that if the proprietor conceals the fact of the appearance of the pest among his cattle, or has been in any way instrumental in bringing it among them when it prevails in the locality, the entire loss which he may sustain falls upon himself, the Government refusing to make any allowance even for those that are ordered to be killed by their officers. This course was, therefore, the one adopted.

The most marked symptoms shown by the animal in question were—a profuse dysenteric purging; indistinct pulse; rapid breathing; surface of body and limbs cold, eyes sunk in their orbits, discharge of mucus mingled with lymph from the eyes and nostrils; staggering gait; and great prostration of strength. Indeed on the way to the quarantine station she fell twice, although the distance was not more than three hundred yards. It was also with much difficulty that she was made to rise. In this condition she lingered on for about eight hours, when death put an end to her sufferings.

The principal lesions met with in making the *post-mortem* examination were — ulcerations at the root of tongue and extensive turgescence of all the surrounding vessels; tonsils loaded with effused lymph, and also all the follicles of the fauces and contiguous parts; large shreds of lymph existed in the windpipe and bronchial tubes. The heart was pale and flaccid. The abomasum was not so much affected as in other cases we have quoted, nor was any portion of either the small or large intestines. Where diseased, the lesions of these viscera were precisely similar to those already described. The mucous membrane of the gall-bladder was extensively diseased, but the ducts of the liver were free from deposits of lymph. Excess of fluid existed in the ventricles of the brain and also in the spinal sheath. All the organs which have not been specially named in this case were free from structural change.

Cases V., VI., VII., VIII.

The animals which formed the subjects of these cases were the companions of Case IV. Three of them exhibited the usual symptoms which are seen at the commencement of the pest on the morning of May 10th, and the other was taken ill during the next day. The character and progress of the symptoms in the first three were about the same as usual, and therefore do not call for any particular remarks. The opportunity was afforded us of watching these animals during the whole of May 10th, the Commissioners allowing them to be kept for that purpose; but on the following day, as soon as the only remaining animal (Case VIII.) was attacked, they were all slaughtered. The malady was quickly running its course at this time, and doubtless would have terminated fatally in all the animals within a day or two; indeed, in one the symptoms were now so much aggravated as to convince us that a few hours would suffice for it to succumb to the pest.

The *post-mortem* examination, which we made in each of these cases, showed that in all essential particulars the morbid changes agreed with those we have already given in detail. Slight differences were observed both in the extent and location of the principal lesions, but these it is unnecessary to describe. Indeed a careful perusal of the cases we have selected for embodiment in this Report will, we hope, sufficiently explain these, even to the medical as to the non-medical reader.

Austria.

In our return journey from Galicia we visited Vienna, and went from thence to Munich, Stuttgardt, and Frankfurt, with a view of ascertaining, by a personal examination, the state of things in Southern Germany and Rhenish Prussia. In no division of the Austrian dominions, except Galicia, has rinderpest prevailed during the present year; Bohemia, Moravia, and even Hungary, have been entirely free from it. The disease existed in several parts of the empire in 1855 and 1856, but was suppressed in the usual manner. It was introduced from Bessarabia, whence it appears that it generally comes.

Some anxiety was shown for fear the malady might be disseminated by the bringing together of animals from different countries at the great Agricultural Exhibition at Vienna, which took place in May last; and the directors of the show, early in April, issued a notice, in which they stated "that the cases of disease which had occurred in Moldavia and Silesia had been confined altogether to the individual animals which had been imported, and that the cattle of the country was free

from all murrain." It was further notified, that on the days appointed for the admission of animals for exhibition the transport to Vienna *of cattle intended for the slaughter-house* would not be permitted by railroad, and that the conveyance of the cattle to be exhibited would be effected in perfectly new waggons.

The extent of the last outbreak in Austria, its duration, &c., will be shown by the official report (p. 266).

The facts set forth in this Report are so explicit that no comments thereon are required; we may, therefore, proceed to state, that after leaving Austria we made our way into

Bavaria.

This country, in common with so many others which we had visited, has likewise been perfectly free from the rinderpest, since from 1813 to 1815; its outbreak at that time being referable to the same cause as in Belgium, &c., namely, the passage of the Austrian army into France. Professor Nicklas, of the Munich Veterinary School, who had returned earlier than ourselves from Galicia, informed us that pleuro-pneumonia was the chief epizootic disease which prevailed in Bavaria, but that it had not existed to any considerable extent of late years. The sanitary laws to limit its spread are similar to those in other countries, being founded on the supposition that the affection is of a contagious nature. Animals which have recovered from an attack are marked on their horns with the letters 'L.S.' signifying that they have been the subjects of the *Lungenseuche*, it being thought that from the partial disorganization of their lungs they may be the means of spreading the disease for several months after their convalescence.

With regard to rinderpest the laws are very severe, and through the kindness of Professor Nicklas we are enabled to give the following details of their provisions:—

"During the continuance of the disease, no cattle, dead or alive, are allowed to be brought across the frontier. Flesh, hides, entrails, horns, hair and tallow of cattle, and bones, whole or crushed, of any animal, with their hair, wool, or bristles, are also especially prevented crossing by the *cordon*; as are woollen cloths, scutchings of leather, feathers, farmyard-manure, hay, clover, straw, and all other descriptions of cattle fodder.

"When the disease occurs on a farm, the affected animals are not removed from the sheds, but the apparently healthy are taken to the quarantine station. Each commune is obliged to provide a station of this description, which is built of wood and divided into two parts, one for the doubtful cases, and the other for the supposed healthy. The Commissioners have the power of allowing medical treatment of the animals, but the veterinary surgeon must remain in the quarantine and receive all he requires at the end of a long pole. All churches, schools, and public-houses of the district are closed so as to prevent the con-

Report on the State and Progress of the Rinderpest in the Austrian Empire in the Years 1855-6.

Governments.	Date of the breaking out of the Disease.	Date of the receipt of the *last* Report.	Number of Cattle in the whole District.	The Disease existed in			Number of Cattle in the affected Villages.	Result.			Date of the disappearance of the Disease.	Remarks.
				Circles.	Villages.	Farms.		Escaped.	Deaths.	Slaughtered.		
Bakowine	1855. Oct. 3	1856. Apr. 15	8,121	..	16	..	699	332	367	..	1856. Apr. 15	
Cracow	Aug. 29	Jan. 31	11,667	2	23	..	881	70	787	24	Jan. 31	
Lemberg	Aug. 29	Nov. 4	79,315	8	200	1,723	8,113	1,679	6,232	97	..	105 in quarantine at the date of the Report.
Ofen	Aug. 20	Nov. 2	49,859	9	85	..	13,335	10,409	2,916	10	..	
Oldenburg	Sept. 5	Jan. 31	8,235	8	21	481	1,981	950	1,006	25	Jan. 31	
Grosswardein ..	May 2	Jan. 28	8,632	1	3	8	3,375	2,343	1,030	2	Jan. 28	
Pressburg	July 23	Feb. 15	54,246	9	114	4,314	15,760	7,845	7,845	70	Feb. 25	
Katchau	July 1	Apr. 8	38,142	6	106	2,926	11,068	6,379	4,575	114	Feb. 28	
Moravia	Sept. 4	Mar. 16	11,568	41	17	507	1,553	230	915	408	Mar. 16	
Upper Austria	Oct. 29	Jan. 4	636	2	3	3	8	..	2	6	Jan. 4	
Lower Austria	1856. Feb. 21	Mar. 12	127	1	1	2	11	..	3	8	Mar. 12	
Total	..	..	270,518	87	589	9,964	56,784	30,237	25,678	764	..	

gregating of people together, and remove those inducements which might cause persons to come from infected farms.

"On the occurrence of illness among cattle from *other* causes as well as the pest, the Commissioners do not as a rule approach the animals, but standing at a distance, and within sight of them, they arrive at a decision as to the nature of the ailment, frequently ordering some food to be offered as a test of their freedom or otherwise from the malady. In those instances where the Commissioners enter the stable, they are compelled, before leaving, to wash their hands, &c., with vinegar, and have their clothes fumigated with chlorine gas. All dogs, cats, rabbits, domestic poultry, pigeons, &c., have to be kept in places of security and close confinement. If the disease exists in a village through which a high road runs, the course of the road is turned if possible; but when this is not practicable, then a guard accompanies the several travellers who arrive at the boundaries of the *cordon* to see that they do not go upon any infected premises. The *cordon* is frequently maintained by the peasants, but none are taken for this purpose from an infected village, the selection being made from contiguous villages or farms where the cattle are healthy.

"As soon as the malady is observed in a commune, notices are sent to all the surrounding places that precautionary measures may be immediately adopted by the owners of cattle. Each commune has to provide a place for the burial of the animals which die or are slaughtered, and also a waggon and horses to carry them upon; and on the disease passing away, the waggon is burnt and the horses are washed with a solution of chlorinated lime. The place of interment is likewise enclosed, and not allowed to be disturbed for several years.

"On an inspection of supposed cases, the animals which give indications of the malady by spasmodic twitchings of the muscles are ordered by the Commissioners to be taken to the burial-ground, where they are killed and interred with their skins on, these being cut in the usual manner. Occasionally a special order of the government permits the removal of the skins, which are then to be subjected to a disinfecting process, under the immediate superintendence of the Commissioners. If but a few cases occur in a large herd of cattle, the Commissioners have the power to suspend the slaughtering of the exposed animals for a few days, in order to watch the result; such animals have a value put upon them, which is paid by the government. Should no animal fall ill within twenty days from the death or slaughtering of the last case, then the quarantine is raised; but the cattle which have been liberated are not allowed to go near to others until they have been washed with a solution of chlorinated lime. On the discharge of the animals the quarantine station is razed and burnt. The Commissioners have to report day by day every occurrence to the Government, and to give the fullest particulars, even to the names of the persons employed at the *cordon*, and the age, colour, sex, &c., of the cattle in the quarantine. The hay on a farm at the time the pest occurred is not allowed to be used for cattle, but must be consumed by horses and sheep."

Such are the regulations existing in Bavaria; in substance they agree with others which have been previously given, but nevertheless we are of opinion that they should find a place in this Report, as several of the details are singularly minute in providing against an extension of the evil. A great difficulty must evidently belong to the carrying out of the requirement respecting the consumption of the hay, and more particularly if the malady should break out in the autumnal period of the year,

as then nearly the whole crop would be in store. This regulation, we believe, has been enforced, because it not unfrequently happens that, in accordance with custom, the whole of the hay of a farm is placed on strong floors above the cattle-sheds, and not put into ricks as in England.

Wurtemburg and the surrounding German States.

We learned from Professor Hering of the Veterinary School at Stuttgardt, that, like Bavaria and other kingdoms and states, Wurtemburg had experienced no outbreak of the rinderpest since 1815, and that its existence at that time was also due to the movements of the Austrian army. The regulations of the sanitary police are almost identical with those in force in Bavaria, both with regard to the rinderpest and also pleuro-pneumonia.

Cattle are reared in large numbers in this kingdom, and are fed for the market principally by the sugar manufacturers, distillers, and brewers. When fat, they are exported for the supply of the French towns, and Paris in particular. With the exception of Swiss cattle, which are imported for the improvement of the native breeds, very few animals are sent into Wurtemburg from any other country.

Rhenish Prussia.

It could hardly have been expected that this province would be found otherwise than perfectly free from the cattle pest. Indeed, in our inquiries of veterinary surgeons, it was somewhat singular that we did not meet with one who had even seen a case of the disease.

Our investigations into the extent of the cattle-pest may be said to have been here brought to a close, and to have shown, that even should a revival of the trade in cattle, which has been spoken of in the former part of this report, take place to England through Holland, by means of the Rhine, there would be no risk incurred of introducing this disease thereby, unless circumstances should unfortunately arise, by which it became as rife as it was in the years 1813, 1814, and 1815.

As the limits which are ordinarily assigned to reports of this description may have possibly been exceeded, we feel that it would not be right to make any observations in addition which are not of a practical character, and therefore we content ourselves by appending a summary of the facts which have been ascertained by us in the fulfilment of our mission.

Conclusions.

1. That all the countries of Northern and Western Europe from which cattle are exported to England are perfectly free

from the Rinderpest; and that the only disease of an Epizootic or destructive nature which prevails therein is the one known to us as Pleuro-pneumonia—which disease has existed here since 1841.

2. That in the greater part of the official despatches and reports which have been forwarded to the Government, and by them transmitted to the Royal Agricultural Society of England, the Rinderpest has been confounded with Pleuro-pneumonia, "Milzbrand," and other destructive maladies to which cattle are liable.

3. That the Rinderpest is a disease which specially belongs to the Steppes of Russia, from which it frequently extends in the ordinary course of the cattle-trade into Hungary, Austria, Galicia, Poland, &c.

4. That whenever circumstances have arisen which called for the movements of troops and consequently the transit of large numbers of cattle in Southern and Eastern Europe, and particularly when Russian troops have crossed the frontier of their territory, the disease has been spread over a far greater extent of country.

5. That the disease which has recently prevailed in Galicia—where it was specially investigated by ourselves—as well as in Poland, Austria, Hungary, the Danubian Provinces, Bessarabia, Turkey, &c., is the true Rinderpest or Steppe Murrain of Russia.

6. That with the exception of a few places in the kingdom of Prussia and others in Moravia, near to the frontier of Galicia and Poland, the disease in its outbreaks of 1855, 1856, and 1857, did not extend to any country lying westward of a line drawn from Memel on the Baltic to Trieste on the Gulf of Venice.

7. That speaking in general terms Rinderpest has not existed in Central and Western Europe for a period of forty-two years; its great prevalence at that time being due to the war which was being then carried on between the different continental Kingdoms and States.

8. That all the facts connected with the history of its several outbreaks concur in proving that the malady does not spread from country to country as an ordinary epizootic. And that, if it were a disease exclusively belonging to this class, the sanitary measures which are had recourse to throughout Europe would be inefficient in preventing its extension, and consequently that in all probability we should long since have been both practically and painfully familiar with it in this country, as hundreds of our cattle would have succumbed to its destructive effects.

9. That it is one of the most infectious maladies of which we have any experience, and that it is capable of being conveyed

from animal to animal by persons and various articles of clothing, &c. which have come in contact with the diseased cattle.

10. That the ox tribe is alone susceptible to the disease; and that the morbific matter on which it depends lies dormant in the system for a period of not less than seven days, and occasionally, according to some continental authorities, as long as twenty days before the symptoms declare themselves.

11. That an attack of the disease which has terminated favourably renders the animal insusceptible to a second action of the *materies morbi* which gives origin to the pest.

12. That the deaths often amount to 90 per cent.

13. That the malady is one in which the blood is early, if not primarily affected; and that subsequently the mucous membranes throughout the entire body become the principal seat of the morbid changes.

14. That the symptoms in general are well marked and quite characteristic of the affection.

15. That all varieties of medical treatment which have as yet been tried have failed in curing the disease; the recoveries which take place having for the most part depended on the *vis medicatrix naturæ.*

16. That no fear need be entertained that this destructive pest will reach our shores. Its present great distance from us would, of itself, afford a fair amount of security; but when we add to this that no cattle find their way from thence directly or indirectly to the English market, and also that in the event of the disease spreading from Galicia, it would have to break through hundreds of military *cordons*, one after the other, before it could possibly reach the *western side* of the German states, and moreover that for years past commerce has been unrestricted with regard to skins, hides, bones, &c., of cattle from Russia and elsewhere, all alarm we believe may cease with reference to its importation into the British Isles.

Jas. B. Simonds.

X.—*On Horseshoeing.* By William Miles.

Although the subject of this paper may not legitimately come under the head of agriculture, it is nevertheless so intimately connected with the interests of the agriculturist, and has been so wofully neglected by him, that I may perhaps be excused for attempting to arouse him to a sense of its importance in a pecuniary point of view. Horses are essential to the carrying on

of his pursuits, he cannot possibly do without them, and a lame one is a very serious and expensive incumbrance to him.

My object, therefore, shall be to show him and others how they may insure to themselves a much larger amount of good and efficient service from their horses than has hitherto been obtained from them, at the small cost of a little attention to the mode in which they are shod, and the general treatment of their feet in the stable. It is too much the habit to consider that shoeing has accomplished all that can be expected of it, if the shoes are only firm on the horse's feet when his master requires his services; whether they are tight and pinch him, or are easy and comfortable to him, are matters that are seldom considered, so long as he can go at all, and contrive to keep himself on his legs, and not diminish his marketable value by tumbling down and breaking his knees; all the pain he endures passes unheeded, except by the poor brute himself, and until he becomes positively lame and useless he receives no sympathy or care from those whose bounden duty it was by timely attention to have spared him. "No foot no horse" is a truth that I doubt not has been realized to many of my readers, when, in the expectation of an agreeable ride either on business or pleasure, they have found their horse emerge from the stable, marking time with his head at every step with the precision of a drill-sergeant.

The first thing that occurs to every one on such occasions is to travel yesterday's journey over again in the mind's eye, in the hope of discovering some particular hole in the road, or some particular stone that must have caused the unlooked-for and unexpected calamity; the bare possibility of its being the gradually developed result of long-continued bad shoeing, and bad treatment in the stable, of course never suggests itself, because the horse has always been treated as other horses are treated, and therefore those things can have nothing whatever to do with it; and this would be considered a sufficient and satisfactory answer to any one who had the temerity to surmise such a cause. I will nevertheless venture to assert, that in nine hundred and ninety-nine cases of foot-lameness out of every thousand, bad shoeing and bad stabling have had more to do with it, than the supposed accident that causes the horse to "drop his head to it," and thereby show that the culminating point had at last been reached, and that he is indisputably lame.

Foot-lameness is a very insidious affair, particularly that most painful and common form of it, navicular lameness. It steals on very gradually, and for the most part unobserved by all but the unfortunate horse; he, poor beast, notes its every stage, and if those who look after him, and those who employ him, would only attend to the indications he gives them, they would know

as much about it as he does, excepting the pain. His courage enables him to bear a good deal without much flinching, nevertheless he soon shows to a close observer that mischief is brewing; the first indication he gives is the straightening of the pastern bone, so as to place the weight of the leg more on the coffin bone, and less on the navicular bone; then, as time goes on, and the pain increases, he relaxes the fetlock joint, and bears less weight on the foot altogether; still there is not much in his mode of standing to attract the attention of a casual observer; his next plan for obtaining relief is to advance the foot slightly, so as to bring the toe of the lame foot a little in front of the toe of the opposite foot, whereby he removes it in some degree from the base which supports his weight.

All this may have been going on for months, and no one have observed it, until at last he can bear the pain no longer, and he thrusts his foot fairly out in front of him in undisguised "pointing;" nevertheless he contrives, when he is at work, by shortening his stride and stepping a little quicker, to conceal the lameness; and the groom and his master become in time so accustomed to his posture in the stable, that they look upon it as a mere trick, and say, "it is all nothing, he always stands so when at rest:" the latter may be true, but the former is something more than doubtful.

Some horses are unquestionably given to tricks, but no horse ever indulges in a trick which compels him to stand almost constantly on two legs instead of four; the pain and inconvenience of such a proceeding would soon induce him to relinquish it as a matter of amusement. Before he can point a fore foot he is obliged to dispense with the support of the opposite hind leg, which he does by relaxing the muscles, lowering the hip, bending the joints, and resting the limb on the toe; he then has to divide his weight as equally as he can between the other hind leg and the opposite fore leg, and having done this he raises the lame foot and deposits it sufficiently forward to insure its exemption from sustaining any portion of his weight; he then lowers his head and neck with a view of still further diminishing the weight on his feet, and presents altogether such a picture of misery, that it would require a very lively imagination in the beholder to suppose the horse is merely indulging himself in an agreeable trick.

The horse's foot is made up of a variety of textures so elaborately and beautifully combined as to form one complicated but perfect spring, and unless that spring is permitted to have constant freedom of action, it very soon gets out of order, the more delicate parts lose their elasticity, and the power of expansion, which is so essential to the soundness of the foot, becomes

first diminished, and ultimately destroyed, whereby the horse is soon rendered useless. I take it there are few persons who will dispute the expansion of the horse's foot, but whatever the general theory about it may be, the all but universal practice is to treat it as an inelastic solid, whose chief use is to pound MacAdamized roads.

The horse in a state of nature roams about at will with his feet unfettered, and they take no harm, simply because he is permitted to look where he is going, pick his way over difficult ground, and direct his own pace; but as soon as he enters the service of man these valuable privileges and safeguards are withdrawn, and the various uses to which he is put, and the rapid rate at which he is required to travel over all sorts of roads, call for some efficient protection to his feet, and it is not only our duty, in return for the important services he renders, to see that it is applied in the manner the least detrimental to him, but it is our interest to do so in anticipation of the lengthened service it will insure to us. If horses were always properly shod, and properly stabled, they would repay the care thus bestowed on them by the increased length of efficient service they would perform. When a horse has worked seven or eight years it is no uncommon thing to hear his master say, "he owes me nothing," which may be perfectly true, considering the treatment he has received; but if he had been properly treated during the time he would be still some eight or ten years of active service in his master's debt.

The horse is a much longer lived animal than people generally suppose him to be; but the prevalent mistake as to the length of his natural life may be attributed to two opposite causes: First, the very large number that are known to die at an early age—victims, it may truly be said, of over-work, bad management, and cruel treatment; and next, the great difficulty there always is of ascertaining the real age of a horse when the mark has disappeared from his mouth. Horses are marketable commodities, and very few persons are disposed to lessen their value, by recording very accurately the number of years that pass over their heads, after the mark is gone; the consequence is, that they remain *about* nine or ten years old so long, that their actual age becomes buried in oblivion, and at last no one really does know how old they are. Many a man at this moment is using a horse, perhaps some eight or ten years older than he thinks he is. I remember many years ago purchasing an active showy horse, said to be about the mysterious age of other people's horses, and there was nothing in his appearance or powers of work to indicate greater age; but on tracing his history I discovered that he was twenty-nine years old, and the sire of a very large progeny.

Now, if I had not taken the trouble to trace him back I should never have known within fifteen or sixteen years how old he really was.

I have, at different times, met with four horses who were all known to be over forty years old, and were still at work; one of them was shot at the age of forty-five, not because he was incapable of further work, but because his master saw the servant ill use him. But, perhaps without taxing my memory for further facts, those supplied by my own stable in November of last year may sufficiently illustrate my position, that the natural life of a horse is longer than it is generally supposed to be. I had at that time six horses in my stable whose combined ages amounted to one hundred and forty-five years, and five of them are still there, with clean legs and hoofs looking like colts' hoofs. The sixth I had destroyed last December at the age of twenty-six. When I purchased him nineteen years ago he had incipient navicular disease, but I contrived by shoeing and stable management to keep it at bay all that time.

The patriarch of the lot, who was bred only five miles from Exeter, has just completed his fortieth year; his early history does not redound to his credit; he was a very unruly, unmanageable brute, and was perpetually changing masters for running away and kicking carriages to pieces; two hackney men in succession tried him, but were obliged to part with him; at length he was handed over to the tender mercies of a commercial traveller, whose long journeys through Devon and Cornwall, after a few years, subdued him, and he became a very useful horse, and at the age of fourteen was sold to a friend of mine, from whom I purchased him exactly twenty years ago. He is a high stepper and remarkably handsome, and if you do not look in his mouth his general appearance would pass muster for nine or ten years old; he is perfectly quiet out of the stable, but he had been so teazed and worried all his life, until he came into my hands, that even now he will not permit a stranger to enter his box alone. The next in seniority is twenty-nine years old, and is the best hack I ever rode. Seventeen years ago, the smith who usually shod him declared his feet to be so far gone that he could shoe him no longer; and he was on the point of being shot, as "used up," and "quite done for," when I came to the rescue, and accepted him as a present, with the view of trying what I could do to put him on his feet again, and the result of my trial has been seventeen years of very efficient service.

There is no specialty attending the history of the other three: one is twenty-one years old, and has been in my possession sixteen years; another is sixteen years old, and has been in my possession nine years; and the last of the six above named horses

is thirteen years old, and I have had him eight years. The horse I purchased to replace the one that was shot in December is seven years old, and was in hard work up to the time I bought him, and although he has been only five months in my possession, his feet and legs have wonderfully improved, and begin to resemble those of my other horses.

If I were asked to account for my horses' legs and feet being in better order than those of my neighbours, I should attribute it to the four following circumstances: First, that they are all shod with few nails, so placed in the shoe as to permit the foot to expand every time they move; secondly, that they all live in boxes instead of stalls, and can move whenever they please; thirdly, that they have two hours daily walking exercise when they are not at work; and fourthly, that I have not a head-stall or rack-chain in my stable: these four circumstances comprehend the whole mystery of keeping horses' legs fine, and their feet in sound working condition up to a good old age. Another case occurs to me, where the same result has followed similar treatment in a mare I purchased for a friend twelve years ago; she was twelve years old when I bought her, and had done a great deal of work; she has ever since been shod by the smiths who shoe my horses, has lived in a loose box, is never tied up, and continues to do her work as pleasantly as ever she did. I may mention, in confirmation of the fact, that my horses are never tied up; that a short time ago a veterinary surgeon, who had occasion to apply a liniment to the throat of one of them, asked for a halter, and learnt to his astonishment that there was not one in the stable; we substituted a watering bridle, and afterwards fastened the horse to the pillar reins, to prevent his rubbing his neck, instead of adopting the usual plan of tying him short by the head to the wall: a watering bridle is at all times preferable to a halter either for commanding or leading a horse.

I am often assured, when talking of shoeing, that it is quite impossible to persuade country smiths to listen for a moment to any new suggestion, or to adopt any new plan, that they are an obstinate prejudiced race, and nothing can induce them to relinquish any of their old notions. I can only say in reply, that this does not at all accord with my experience of them as a class; on the contrary, I have found them, for the most part, to be hard-working, painstaking men, evincing great interest in their work, and anxious to do it as well as they could. I do not mean to say that there are no exceptions, because I know there are; but the exceptions do not disprove the rule.

Before we consent to condemn them in a body let us see how

the matter really stands between them and their employers, who accuse them of prejudice and obstinacy. We must not forget that they have been accustomed from the period of their apprenticeship to shoe horses in one particular manner, which has hitherto given satisfaction, and, as far as they know to the contrary, they have never lamed a horse.

We must not be surprised, if, under these circumstances, they should show great reluctance to relinquish plans which long habit has rendered almost second nature to them, or if they require to be thoroughly convinced of the practicability and superiority of a new plan, before they consent to give up the old one; and as it is much more difficult to efface what has been already learnt than to teach what is new, he who undertakes to become an instructor, must at least be sufficiently master of his subject to be able to point out pretty clearly the advantages of the plan he proposes over that which he desires to alter; to which end he must acquaint himself with the details of his plan before he ventures into the forge, for an intelligent smith will make a very accurate estimate of his fitness to teach before he has been many minutes there; and I have no doubt but much of the obstinacy and perversity one hears of may be traced to the smith's having received impracticable, if not impossible, directions. And surely it is not very unreasonable in him to object to carry out details which he does not comprehend, and which he strongly suspects his instructor is not very clear about, when he knows full well that he would decline to share the blame with him, in case the experiment should fail, and the horse cast a shoe.

I have been sometimes surprised at the readiness with which smiths have yielded their opinion to me, as soon as they found that I really knew what I was talking about, and that I could not only give them directions, but show them exactly how to carry them out in detail, and, if I had only possessed the brawny arm which is necessary for such a purpose, that I could have forged the shoe and fitted it to the foot. They all feel that horseshoeing is open to improvement, and as a class they are anxious for information that they can depend on, but they are naturally very shy of relinquishing plans which they have been long accustomed to for others which they do not comprehend; but any gentleman who will take the trouble to acquaint himself with the principle and details of the plan which I advocate, will very soon become a welcome visitor at the forge, and while he is improving the condition of his own horses' feet, he will find that he is indoctrinating the whole district to the great benefit of his neighbours; for although they will not take trouble themselves, they are soon ready to avail themselves of the trouble

taken by others, and will send their horses to the man who can shoe them best, and that causes the other smiths to look about them and change their plans.

A few years ago I rented a house for the summer near to a country village, and was very soon waited on by the smith with specimens of his shoes, and a foot shod in his very best manner; and as examples of careful finish they were very pretty things to look at; but when I descended from the ornamental to the useful, and began to point out the defects one after the other, he looked astonished, and not very well pleased; he was, however, somewhat consoled by my telling him that I would have one of my horses brought to his forge on the following morning, and then I would show him what I meant. I kept my word, and finding that he entered with interest into my views, and tried his best to understand and carry them out, I took some trouble with him, and frequently looked in and directed him at his work. One day I found him turning store-shoes of a better form than any I had yet seen in his forge, and observing to him that they were more like what I meant, he said, "Oh yes, I have got it now, Sir; my shoes were all too short to fit as they ought to do;" and pointing to some that were hanging against the wall, he added, "before you came here I used to feel very proud of those shoes, but now it makes me ill to look at them, and I don't think I could ever make one like them again." He had become a really good shoer, and understood how to fit a shoe properly, and I think he would have found it a difficult job to fall back on his old pattern again. His fame soon spread, and he obtained the shoeing of all the gentlemen's horses for several miles around him. Similar results have followed in other instances where I have bestowed a little trouble, and I must say that I have invariably received civility and attention at the time and on many occasions expressions of great gratitude afterwards.

Many persons have been deterred from interfering with the smith, because, as they have told me, they knew nothing whatever about the anatomy or physiology of the horse's foot, and had neither the time nor the inclination to study it; but such knowledge is not at all necessary to a thorough acquaintance with the principle and practice of horseshoeing; if it were, they might well be excused for not attempting it: all that is really required of them is to take one anatomical and one physiological fact on trust, and believe that the horse's hoof is lined by a very sensitive membrane, which must on no account ever be wounded, and that the hoof itself is elastic, and expands when the weight of the horse is thrown on the foot, and contracts when it is taken off again; all the rest is purely mechanical and merely calls for the

exercise of a little thought and patience to understand the principle and apply it.

But before I enter on details let me dispose of one subject that has given rise to much unnecessary thought and controversy—I mean the very generally entertained notion, that particular kinds of roads and certain kinds of work call for separate and distinct methods of shoeing—which has greatly complicated and mystified a very simple and straightforward matter: the truth is, that no system of shoeing is worth one moment's thought or consideration that will not answer equally well in every description of ground, and for every kind of work.

It has been supposed that the hunter forms a special exception, but the experience of a large number of gentlemen in various parts of the country during the last ten years has entirely dispelled the fallacy, and proved beyond dispute that the torture inflicted on hunters by nailing the shoes from heel to heel, with a view of keeping them on their feet, is an unnecessary act of cruelty perpetrated to support the notion, that deep ground would pull the shoes off unless they were secured by extra nails; but if a shoe fits the foot as it ought to do, and is perfectly fastened to it by five nails, nothing short of a violent wrench from the smith's pincers can remove it. This has been proved in numberless instances, not only by myself but by others in various hunting countries, who have kindly communicated to me the result of their experience after a fair trial of the plan of shoeing and general treatment of the horse's foot, which I recommended in a work I published some years ago on that subject, and which an officer of Prussian Hussars desired my permission to translate and publish in German; and he writes me that he and several of his brother officers have had their horses shod as I have directed, and that they never lose a shoe. It would be a useless waste of time to go over all the proofs again; nevertheless, as I am now writing for agricultural readers, it is desirable that I should be able to show to them, beyond the possibility of doubt, that the mode of shoeing which I recommend will stand the test of the deep clay ground their horses are sometimes called upon to work in; and in order to qualify myself to speak with authority in this matter, I have lately instituted an experiment which I think will carry conviction to the mind of the most sceptical.

The two subjects of my experiment were horses employed in drawing materials for a large public building in course of erection in a deep clay meadow, and I chose the particular time for making the experiment, because the unusual quantity of rain that had fallen during the preceding six weeks had rendered the ground, both in the meadow and at the quarry from which the stone was drawn, as deep and clinging as it is possible to con-

ceive ground to be. One of the horses was the property of the builder, and the other belonged to the person who had contracted to draw the stone from the quarry, and whose horses are chiefly employed in drawing either timber or stone, than which no work can be more trying to the security of horses' shoes at such a season, and in such a county as Devon. I was present at the shoeing of these horses, and saw them both shod with five nails only in each fore shoe and a clip at the toe. The shoes were plain waggon-horse shoes, with stamped holes and no fullering. The builder's horse was a fair average cart horse 15 hands $3\frac{1}{2}$ inches high, and the shoes that were put on him weighed 1 lb. 14 ozs. each. The contractor's horse was a heavy waggon horse 16 hands and an inch high; and I could scarcely have found a fairer subject for my experiment: he has remarkably weak feet, with hoofs full of what smiths call shaky places, and he is so hot and impetuous in his work that the driver never can prevent him doing much more than his share. I had one of his shoes measured and weighed just before it was nailed on, and found it to be 6 inches across from side to side at the quarters, and 7 inches from toe to heel, and it weighed exactly $2\frac{1}{2}$ lbs., so that each nail in his shoe had to retain half a pound weight of iron and hold it to his foot.

I visited both the horses at the end of a fortnight, and found their shoes not only safe on their feet, but not a clinch had risen, neither had either of their shoes shifted in the smallest degree. I was fortunate enough to meet the larger horse coming from the quarry with a load of stone, and anything more satisfactory to me, as regarded my experiment, or less satisfactory to the poor brute, I cannot conceive; for he was literally plastered up to the knees and hocks with a thick layer of red clay, and the spokes of the wheels were in a like condition up to the nave, showing pretty clearly the kind of ground he had had to deal with, and the sort of test that had been applied to the security of his shoes.

At the expiration of another fortnight I again examined the shoes of both the horses, and finding those of the larger horse completely worn out, I had them taken off and replaced by new ones fastened by five nails; the shoes of the other horse not being worn out, I permitted him to carry them another week, and then, considering he had worn them long enough for my purpose, I had him reshod; but wishing to make my experiment as perfect as I could, I had two of the nails omitted, and shod him with *three* nails only in each fore shoe; and at the end of four weeks I saw him at work with his shoes safe on his feet. I do not mention this fact with the view of trying to persuade others to shoe their horses with only *three* nails, although I have not had more than three nails in a fore

shoe of any horse belonging to me for several years past, neither do I intend to increase the number: I merely record the fact to show that no one need fear to trust their horses' shoes to the keeping of *five* nails.

The result of the numberless experiments I have made at various times, on all sorts of horses doing every kind of work, is, that there is but one principle to be observed in horseshoeing, which will admit of no variation or compromise: *the shoe must fit the foot, whatever the shape of the foot may happen to be, and it must be nailed to the hoof in such a manner as will permit the foot to expand to the weight of the horse;* this latter condition will be best complied with by placing three nails in the outer limb of the shoe, and two in the inner limb between the toe and the commencement of the inner quarter; a larger number than five nails can never be required in any shoe of any size, or under any circumstances, excepting for the sole purpose of counteracting defective and clumsy fitting. I will now proceed to describe, as shortly as I can, the details of the plan I recommend; and if it should appear, to those who have done me the honour to read what I have already published, that I have repeated myself, I can only answer that the details of a fixed plan will admit of no variation in substance, and very little in words.

The first thing requiring attention is the removal of the old shoes, which should be done with much more care than is usually bestowed on it, and without any of that violent wrenching from side to side one too often witnesses, whereby the clenches are dragged through the crust by main force, and the horn wantonly and unnecessarily destroyed. It is very little trouble to raise the clenches with the buffer, and, if the nails should still retain a firm hold and resist a moderate effort to displace the shoe, the punch should be used to loosen them, so as to cause the shoe to come off easily and without damage to the hoof. The smith will be amply repaid for his trouble by the unbroken horn he will find to nail to, and the firmer hold he will obtain for his nails when he comes to nail on the new shoe. Having taken off the shoe the rasp should be passed round the lower edge of the crust before the foot is let down, to remove the jagged edge, and also to ascertain that there are no stubs remaining in the horn: if the edge is not rasped it is apt to split and break when the horse moves, which he is sure to do as soon as his foot is on the ground again. No horse should have more than one foot bared at a time; however strong his feet may happen to be, he is sure to stand quieter on a shod foot than he can on a bare one, and it will prevent his breaking the crust. A horse with weak flat feet is in positive misery when forced to sustain his whole weight on a bare foot, while the opposite foot is held up.

Previous to preparing the foot for the reception of the new shoe, we must consider, first, the kind of foot we have to deal with; and next, the condition of the roads it will have to travel upon; for it would be manifestly improper to pare a weak flat sole as much as a strong arched one, or to pare either as much when the roads are hard and covered with loose stones as when they are moist and even. No general rule, therefore, can be laid down that would apply to all kinds of feet, or indeed to the same foot at all times; the amount of paring the foot is to undergo must entirely depend on the above considerations.

A strong foot with an arched sole, when the roads are in good order, will require to have the toe shortened, the quarters and heels lowered, and the sole pared, until it will yield in some slight degree to very hard pressure from the thumb; but on no account should it ever be pared thin enough to yield to moderate pressure: the angles formed by the crust, and the bars at the heels, must be cleared out. and all the dead horn removed therefrom, and the bars should be lowered nearly to a level with the sole.

A weak flat foot, on the contrary, will bear no shortening of the toe, and very little paring or lowering anywhere; the heels of such feet are sure to be too low already, and the sole too thin; in fact, the less that is done to them the better beyond clearing out the dead horn from the angles at the heels, and making the crust bear evenly on the shoe; but the hollow between the bars and the frog, or the frog itself, must never be touched by a knife in any foot, whether it be a weak one or a strong one, and as these latter directions differ so materially from the usual practice of smiths, I may perhaps be expected to state my reasons for wishing to enforce them in opposition to what they no doubt consider a time-honoured custom; I mean, the inveterate habit they all have of trimming the frog, and opening out the heels at every shoeing; but I think I shall be able to show, that "it is a custom more honoured in the breach than the observance."

The bars are not separate and distinct portions of the hoof, but simply continuations of the crust reflected or turned back at each heel in the direction of the centre of the sole, where they meet in a point and form a triangular space for the reception of the elastic cushion, usually called the sensible frog: each of these reflected portions, at its deepest part, rises about an inch into the cavity of the hoof, and is connected at its upper part, throughout its whole extent, on one edge with the horny sole, and on the other with the horny frog, whereby the horny covering of the foot is completed and made continuous. This doubling back of the crust on each side, from the heel to the point of the frog,

together with the increased thickness of the crust itself at the extremity of each heel, is evidently designed to keep the heels apart, and prevent their pressing inconveniently on the structures within the hoof; and if the substance of the horn be thinned by paring the sides of it, it is clear that its power of resistance must be diminished, the natural action of the foot damaged, and the chance of contraction greatly increased. Many smiths, who are merciless in paring the sides of the bars, which ought never to be touched by a knife, waste much time and patience in preserving the portion that projects beyond the surface of the sole, which they had better have pared down nearly to a level with the sole, as it only impedes the removal of the dead horn from the corner of the sole at the heel, and would have been worn away, if the presence of the shoe had not prevented it.

The frog may be said to consist of three portions, viz., the horny frog, the sensitive frog, and a thick elastic cushion, which is interposed between the sensitive frog and the navicular joint, for the purpose of protecting this important little joint from injury: the portion, however, with which we are now more immediately concerned, as connected with the mechanical art of shoeing, is the horny frog.

No part of the foot shows the difference between good shoeing and bad so soon, or so palpably, as the frog. The frog of a foot that has been well shod for some time presents a full, plump appearance, with an even surface and a broad oval cleft, with a well-defined edge, not broken through at the back; whereas a frog, that has been long subjected to bad treatment, is shrunk and hard, with a ragged uneven surface and a narrow cleft broken through at the back, and extending up between the bulbs of the heels. The horn of the frog is thinner and of a closer and more delicate texture than the horn of the hoof, and is evidently intended not only to protect the parts immediately above it, but also to prevent the evaporation of the moisture which keeps these parts in a soft, yielding condition; but it cuts so easily, and looks so clean and trim when its surface is pared off, that very few smiths indeed can be prevailed on to leave it alone, and not even cut off the rags; nevertheless they had better do so, for those very rags which they think it desirable to remove were caused by paring off the surface of the horn at the last shoeing, whereby a part was lain bare that never was intended to be exposed to the action of the air, and which in consequence became dry and hard, and soon cracked, and the edges having curled outwards formed the rags which are so offensive to the eye of the smith; and, if he should be tempted to remove them, he will again lay the foundation of other cracks and other rags, until at last the frog will have dwindled down by

small degrees to half its original size. Now if, instead of persisting in this gradual work of destruction, he would only leave the frog alone, and never touch it with a knife, the rags in due time would entirely disappear, and the frog become covered by a coating of newly secreted horn. The horn of the frog, when left to itself, is always undergoing a process of exfoliation and reproduction. The exfoliation for the most part occurs in small particles, resembling the dust which adheres to Turkey figs; but at other times the whole surface of the frog will exfoliate in a mass, leaving a smaller, but still perfect, frog beneath, covered with sound horn. The small particles of exfoliated horn may best be seen in the feet of horses shod with leather, where the artificial covering has prevented their escape; and so little is this natural process of exfoliation understood by horse-masters in general, that I have frequently had my attention gravely directed to the accumulation of these particles, as unmistakable evidence of the leather having rotted the frog.

The shoe should be neither too light, nor too narrow in the web: light shoes are apt to bend before they are half-worn out, and narrow-webbed shoes expose the sole and frog to unnecessary injury from stones in the road. Every fore-shoe should be more or less seated on the foot-surface, to prevent it pressing on and bruising the sole; but a perfectly flat surface should be preserved around the edge of the foot-surface of the shoe from heel to heel for the crust to rest upon. The amount of seating to be employed must be determined by the description of foot to be shod; for instance, a broad foot, with a flat sole and weak horn, will require a wide web, considerably seated, to prevent it coming in contact with the sole and bruising it; but a narrow foot, with an arched sole and strong horn, will require less width of web and less seating, otherwise the dirt and grit of the road would become impacted between the shoe and the sole, and cause as much pressure and injury as the iron would have done.

The safest guide to the proper amount of seating is to apply the shoe to the foot, and observe whether there is room for a picker to pass freely between the shoe and the sole; if there should not be sufficient space for a free passage all round the shoe the seating must be increased; and if there should be more than is necessary, it must be diminished. The smith, having carefully prepared the foot, and selected a shoe with a proper amount of seating for it, has next to cut off the heels, and fit the shoe to the foot; and he must always bear in mind, that fitting the *shoe* to the *foot* does not mean fitting the *foot* to the *shoe*—an error that smiths are prone to fall into.

I have very frequently had occasion to remind a smith, that he was saving himself trouble at the expense of the horse by accom-

modating the foot to the shoe, instead of altering the shoe to the foot; and it must be confessed, that unless a smith is encouraged to take an interest in his work, by the owner of the horse paying an occasional visit to the forge, and showing that he, too, is interested, it is very tempting to him, when he finds the foot and the shoe do not come well together, to adopt the more expeditious and less troublesome course of substituting the knife and rasp for the hammer and anvil. Every forge is expected to be supplied with store shoes "turned in the rough," and if they were left longer in proportion to their width, and straighter at the quarters, with the heels wider apart than we usually find them, the labour of fitting the foot accurately would be greatly diminished, as we shall see when we come to consider that part of our subject. The first thing, however, that demands our attention is the mode of cutting off the heels to the required length; and for this purpose a curved chisel, as shown in Fig. 1, is a more convenient tool than a straight one, and saves the smith much trouble in "filing up" the shoe before he nails it to the foot; it removes the corners and rounds the points of the heels at once, and enables him to fit the heels of the shoe to the heels of the hoof with greater nicety than he can possibly do when they are cut off square.

Fig. 1.

The best manner of proceeding is to remove a small corner from the outer rim on each side, and a larger and longer portion from the inner rim, as shown by the dotted lines A B C, in Fig. 2. By this mode of cutting off the heels the outer rim of the shoe is lengthened, and the inner rim shortened, without diminishing the width of the web, as shown at A C, in Fig. 3. After the heels have been cut off, as directed above, the nail-holes should be opened; and the best mode of doing it is to make them pass straight through the shoe, instead of inclining inwards in the direction of the centre of the hoof, as

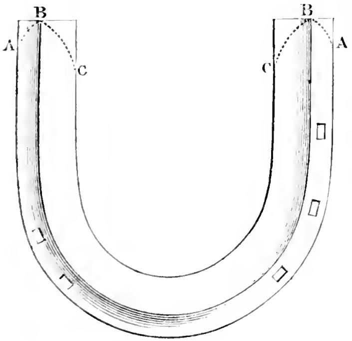

Fig. 2.

is almost invariably done, the effect of which is to convert a simple and safe operation into one of difficulty and danger, for the nails must first be driven with their points inclining inwards, and then outwards, until at last they emerge high up in the thinnest part of the crust, having split their way out in the direction of the fibres of the horn, with a great probability of some portion of the shanks lying so close to the sensitive lining of the hoof as to press upon it when the foot is in action and expands. Where the holes are thus made to incline inwards it requires considerable dexterity to drive the nails so as to steer clear of the many dangers that lie in the way. I do not allude to the graver matter of pricking the foot, as it is called, but to the thousand and one varying degrees of pressure from the shanks of the nails, causing constant uneasiness, or, it may be, pain in the foot. If the quick has been wounded the horse soon tells the tale, but if he is only uneasy from pressure, he bears it patiently, and it is never known to his master, although it is very frequently the unsuspected cause of broken knees.

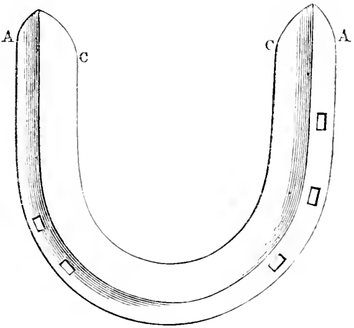

Fig. 3.

We hear much about rolling stones in the road causing broken knees: a rolling stone is a very convenient scapegoat for a large amount of bad riding, bad driving, and bad shoeing; but, I take it, we should be much nearer the truth, in nine cases out of ten, if we attributed the misfortune to misplaced nails, driven through holes slanting inwards. When the nail-holes are made to pass straight through the substance of the iron, and the angle at which the hoof meets the shoe is considered, it will be self-evident that nails, driven *straight* through those holes, must cross the grain of the horn and come out low in the crust, presenting the strongest portion of the shank for a clench; and my experience tends to show, that nails so driven obtain a much firmer hold in consequence of their piercing the horn *across* the grain, than nails driven higher up the crust *with* the grain.

A few observations on the fuller, or groove in which the nail-holes are stamped, may not be out of place here, with a view to correct an error that almost all smiths fall into, of making their fullering-irons so fine and thin, that the grooves produced by

them will not permit the heads of the nails to sink into them as they ought to do. They appear to forget that the safety of a half-worn-out shoe depends on the heads of the nails having sunk well into the groove, and fairly blocked the bottom of the holes. They are all impressed with the notion that a narrow fuller, with sharp well-defined edges, looks neat and indicates skilful workmanship; and perhaps it does look neater than a coarse, open groove, but it is attended with the great disadvantage of being much less useful. An open fuller affords more space for the head of the nail, and prevents its becoming tied in the upper part of the groove before the lower portion has descended to the bottom of the hole, which invariably happens when the fuller is deep and narrow.

Horse-shoeing at best is but a necessary evil, and cannot be elevated to the rank of an ornamental art; smiths had better, therefore, confine their views to the utilitarian principle entirely, and thereby endeavour to make it as little hurtful to the horse, and as little inconvenient to his master, as they possibly can.

Having cut off the heels and opened the nail-holes, the next thing to be done is to turn up a clip at the toe preparatory to fitting the shoe to the foot, which latter operation should always be commenced at the front of the foot, and be gradually and carefully carried back to the quarters and heels. Every shoe should have a clip at the toe, to prevent the shoe being driven back on the foot and bending the nails in the crust; but I strongly object to the clip, which I often see turned up on the outside of a shoe, which is not only useless but destroys more horn than two or three nails would do.

No one doubts the fact of horses travelling safer and better in shoes a week or two old than they do in perfectly new ones; and this arises from the fact of their having worn away a portion of the iron at the toe, and thereby diminished the jar which the foot had previously received from the front of the toe coming in direct contact with the surface of the road. In order to relieve the horse from any unnecessary jar to the foot I always have the whole breadth of the toe of the shoe turned up, so as to raise the ground-surface of the shoe at the toe above the level of the ground, by which arrangement horses are found to trip less, and put their feet down with greater confidence. The plan of welding a lump of steel on to the toe of the shoe only makes bad worse; it increases the jar, is longer wearing away, and causes the horse to trip more and for a greater length of time; whereas turning up the toe of the shoe obviates the evil at once, and makes the shoe last quite as long as the steel would have done. All feet will not bear the same amount of elevation of the toe: strong feet will bear a good deal, but flat feet with weak horn

will bear only a little; still that little should be imparted to the shoe. The old shoe, placed on a flat surface, will afford a very good guide to the amount of elevation to be given to the toe of the new shoe, provided the old one is not worn so much as to be thoroughly and entirely worn out.

A very convenient and handy tool for turning up the toe of a shoe may be made by welding a piece of bar-iron five inches long, one inch broad, and somewhat less than a quarter of an inch thick, crosswise on to each blade of a pair of smith's tongs. Any smith can manufacture such a tool for himself, and will find it very useful by enabling him to grasp both limbs of the shoe at the same time, and turn up the toe over the end of the anvil without twisting the shoe, which he could not do with common tongs; and he can easily restore the seating at the toe by merely turning the shoe on the anvil. Fig. 4 will show this tool in use. Having turned up the toe of the shoe and fitted it carefully to the toe of the hoof, the smith must direct his attention to the quarters and heels, and whatever shape they may happen to take, that shape must be implicitly followed by the shoe; whether the quarters be straight or curved, or the heels narrow or open, the shoe must follow the same shape: it is a grievous mistake to suppose, as too many persons do, that it is in the power of the smith to change the form of the foot by merely changing the form of the shoe: what are called open-heeled shoes will not make open-heeled feet. The situation of the nails alone can alter the form of the foot, either by preventing or permitting the hoof to expand to the weight of the horse. If the shoe is nailed from heel to heel the hoof cannot expand, and the foot must become damaged; but if it be nailed, as I direct, with three nails on the outside and two on the inside, a foot, that has been already damaged by bad shoeing, may to a great extent be restored by thus permitting the foot to expand.

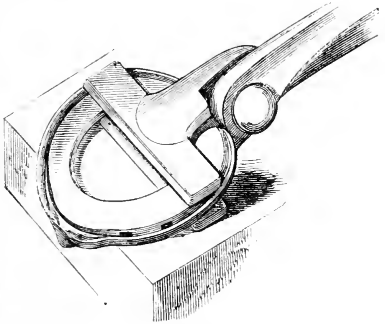

Fig. 4.

As a general rule, the first nail on the outside should be placed an inch and a half from the centre of the toe, the second in the middle of the quarter, and the third just behind the quarter; and on

the inside, the first nail should be rather more than an inch from the centre of the toe, and the second about three-quarters of an inch behind it; by this arrangement the whole of the inner quarter and heel are left unfettered and free to expand, and any undue pressure on the sensitive parts of the foot, from the descent of the bones into the hoof, is avoided. Fitting the heels will call for a little extra care at first, as it involves the abandonment of some deep-rooted prejudices and groundless fears. First, the prejudice in favour of square heels projecting beyond the hoof, both behind and at the sides, must be yielded; and the fear lest the smallest portion of the shoe should happen to touch the frog must be given up, before anything like accurate fitting can be obtained. The edge of the shoe must be made to correspond with the edge of the hoof all round, from heel to heel, and to do this effectually, and keep the web of the shoe as wide at the heels as it is at the toe, the heels must be brought in until they very nearly touch the frog. I would not have them bear on the frog, but I would rather see them touch it than be able to lay my finger between the frog and the shoe.

There are many advantages attending the bringing in of the heels, and not one single disadvantage to set against them. In the first place, it removes all the points and projections by which stiff ground is enabled to pull off the shoe; in the next place, it affords a good, firm, flat surface for the heels of the hoof to rest upon, and, by bringing the sides of the shoe nearer together, the navicular joint, which lies in the hoof above the frog and about an inch from its point, is saved from many an unlucky jar from a stone in the road, by the shoe receiving it instead of the frog. The shoe must not only fit the edge of the crust, but the whole of the crust must have an even bearing on the shoe, and this can only be effected by making the shoe hot enough to scorch the horn, and applying it to the foot. The quantity of horn to be thus destroyed, when the foot and shoe have both been made as level as the smith can make them, is very inconsiderable, and the heat so applied can do no harm. I would not have the shoe burnt into its place on the foot without previous preparation, as is very often done to save a little trouble, but I would have the hot shoe applied so as to insure a close fit all round. A thin, weak hoof will not bear as much heat, without inconvenience to the horse, as a strong one; but as a close fit is of even more importance to a weak hoof than it is to a strong one, it is essential that the shoe be applied to it hot enough to scorch the projecting portions of horn, in order that they may be seen, and removed by a rasp.

It is a very good plan, in fitting the shoe to the inner quarter and heel, to keep the rim of the ground-surface of the web within the

rim of the foot-surface, somewhat after the fashion of the shoe in common use for preventing cutting; it enables the horse to withdraw his shoe from stiff ground without the chance of leaving it behind him, which he will inevitably do if any portion of the shoe is permitted to project beyond the hoof. When the shoe has been carefully fitted to the foot it must be cooled and "back-holed;" that is, the nail-holes must be opened on the foot-surface of the shoe; and in doing this care must be taken to break down the *outer* edge of all the holes, so that the nail may pass straight through the shoe without any inclination inwards, and the openings should be made large and free, to prevent the shank of the nail becoming tied in the hole before the head has been driven fairly home.

The shoe has then to be "filed up" preparatory to being nailed to the foot; and I may here observe, that much time and labour are generally wasted in polishing portions of the shoe which might very well be left alone; all that is really necessary is to round off the sharp edges, remove any "burs" that may project from the surface, and file the foot-surface of the heels, as shown at F, in Fig. 5. Fig. 5 shows the foot-surface of a near fore-shoe; A, the clip at the toe; B 1, the outer quarter; B 2, the inner quarter; C 1, the outer heel; C 2, the inner heel; D, the seating; E, an even flat surface from heel to heel for the crust to bear upon, and in which the nail-holes must be placed. They must never be permitted to encroach on the seating, but be always confined to this flat surface; F, the ends of the heels filed away in a direction upwards and outwards, the object being to prevent pressure on the frog without diminishing the width of the web on the ground-surface of the shoe.

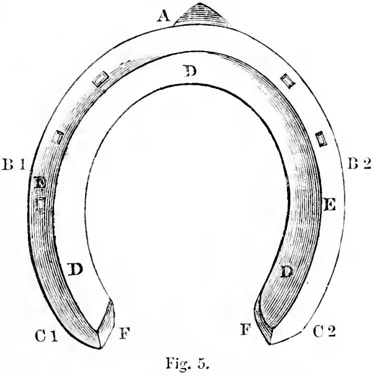

Fig. 5.

Fig. 6, the ground-surface of the same shoe. A, the toe turned up out of the line of wear; B 1, the outer quarter; B 2, the inner quarter; C 1 and C 2, the heels; with D, the web as wide as at any other portion of the shoe; E, the fuller. It will be observed that the inner quarter of the shoe, marked

B 2 in each of the figures, is considerably straighter than the outer quarter marked B 1, which is the natural shape of a well-formed foot: the inner quarter is not only straighter and more upright than the outer quarter, but the crust is thinner and more elastic, and consequently expands in a greater degree to the horse's weight; but when we talk of the hoof being elastic and the foot expanding, we would by no means have it inferred that they bear any relation to the elasticity or expansion of India-rubber; if they did, the bones of the foot would be thrust through the hoof during violent action, or in a down leap. The elasticity and expansion are small in degree, scarcely exceeding the eighth of an inch in the feet of most horses, that have been several times shod, but they are most important in their consequences, by affording exactly the amount of enlargement of the cavity necessary for the descent of the bones of the foot, without squeezing the sensitive parts which line the hoof.

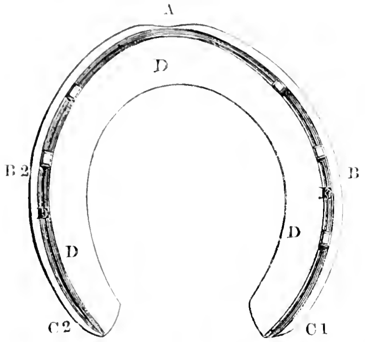

Fig. 6.

Before I say anything about nailing the shoe to the foot, I have a few observations to offer on the nails usually employed for the purpose, which are very defective in form and ill-contrived for obtaining a firm and lasting hold, although I am bound to confess that I have lately seen a manifest improvement in some of the nails of commerce; but the general run of them are made with heads so short, square, and broad at the top, and so small and narrow at the bottom, with shanks springing suddenly from them, that the upper part becomes tied in the fuller before the lower part has reached the bottom of the hole, and the consequence is, that the bottom of the hole is occupied by the shank alone, and before the shoe is worn out the head of the nail is gone, and little more than a brad remains to retain the shoe.

The smiths who shoe my horses make their own nails, and I recommend others to do the like, at least for the better class of horses; it gives them an opportunity of choosing their rods, making their nails of a better shape, and cooling them more gradually than the wholesale manufacturers do, whereby they are rendered tougher

and less liable to break. The head of the nail should be oblong on the top, straight-sided at the upper part, and die away gradually into the shank with a broadish shoulder, to fill the opening made by "back-holeing" the shoe; hence the necessity for these openings being larger and freer than they are usually made. A nail so formed will always retain the semblance of a head, and can never be reduced to a mere headless brad. The shank should be less taper, and the point less elongated, than those of the nails in common use; the shorter point and broader shank supply a firmer and better clench. Fig. 7 represents the two nails I have been endeavouring to describe; but a comparison of the letters attached to each will perhaps convey more clearly what I mean than my words may have done. When the nail-holes are in the right places and pass straight through the shoe, and the shoe has been properly fitted to the foot, the difficulty of nailing it on is reduced to nothing, and might almost be handed over to a carpenter to do with as much confidence as to a smith; the nails have only to be driven straight, and they must pass through the shoe, across the substance of the horn, avoid the sensitive parts altogether, and come out in their right places, presenting the strongest portion of the shank for a clench, instead of the thin narrow point; the smith has then only to twist off the projecting portion of the nails, cut a notch in the hoof to receive the turned-down clench, and bury it with his hammer in the notch so formed, and not touch it again with a rasp; in fact, a rasp should on no account whatever be applied to the surface of the hoof above the clenches; it tears and destroys nature's covering, designed to keep the horn moist and tough, and renders it dry and brittle.

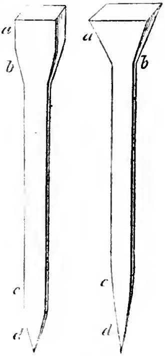

Fig. 7.

I shall, no doubt, astonish some persons when I assert that nearly all the evils incident to horse-shoeing are attributable to the affectation and dandyism of the smith, who is not contented to follow a necessary and useful art, simple in its mechanical parts, but calling for the exercise of some judgment in its application, but he must import into it dangerous difficulties and mischievous ornament; for instance, he assumes that a deep narrow fuller, with small nail-holes inclining inwards, and still smaller openings on the foot surface of the shoe, present a neat, trim appearance, and show that he is master of his art; knowing full well, that nothing but long practice could enable any one to navigate a nail safely through a channel beset by so many dangers; but he entirely overlooks the

fact that the power to do so has nothing to recommend it but the danger and risk attending the performance. Again, he imagines that a hoof carefully rasped all over imparts an air of finish to his work, of which he feels proud, forgetting altogether that he has removed a most important covering from the hoof, for which no amount of ornamental finish can compensate.

I am anxious again to impress on smiths and their employers that horse-shoeing is at best but a necessary evil, and that any attempt to raise it to the rank of an ornamental art must be attended with damage to the horse and inconvenience to its owner. My sole object is to render it as safe, simple, and useful as possible; to divest it of all difficult and dandy crotchets in its application, and reduce it to one principle, to be carried out in the shoeing of all sorts of horses, at all sorts of work.

This principle, which admits of no variation, may be summed up as follows: the shoe must fit the foot from heel to heel, whatever the shape of the foot may be, and the crust must have an equable bearing on the shoe all round; the toe of the shoe must have a clip in the centre, and, when the foot will bear it, the toe must be elevated from the ground; the nail-holes must be so placed as not to encroach on the inner quarter, but leave the inner quarter and heel free to expand, and they must pass straight through the shoe; the frog must never be touched by a knife, or the surface of the hoof by a rasp. The detail may fairly be left to the judgment of the smith, who will be able to determine the description of shoe best calculated to meet the requirements of the foot that he has to deal with; he will have to consider whether it is strong and upright, or weak and flat, and be guided by those circumstances as to the substance, width of web, and amount of seating the shoe must possess, and also the degree of elevation of the toe the foot will bear. These are matters of detail infringing no part of the principle, and may and ought to be left to the experience and judgment of the smith. Fig. 8 represents the ground surface of a near fore foot, shod as it ought to be, and fig. 9 represents the same foot, with the shoe rendered trans-

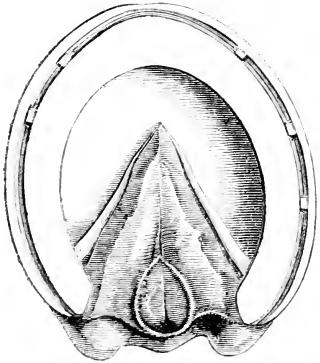

Fig. 8.

parent, showing the portions of the foot that are covered and protected by it, A the crust, B the bars, and C the heels; it will be seen, moreover, how bringing in the heels diminishes the opening of the shoe and lessens the chance of stones in the road bruising the frog; one side or other of the shoe would alight upon them and save the frog. I may observe in passing, that corns have never failed to disappear under this mode of shoeing; they are always the consequence of bad shoeing, and good shoeing always removes them. I could not keep a corn in my stable, if I desired it ever so much, unless I altered my plan of shoeing. A large number of flat-footed horses cannot go safely at any time without some protection over the sole, and all horses would be benefited by it when the roads are strewed with loose stones; but it is a mistake to suppose that leather, or any substitute for it, inserted between the shoe and foot, calls for a greater amount of fastening than five nails; they will retain a shoe, with leather under it, as firmly as if the leather were not there: all that is required is, to make the leather fit the shoe as accurately as I desire the shoe to fit the foot, and that no projecting portions be left either behind or at the sides of the heels, and instead of the leather being cut square at the heels, I would have it slightly arched inwards from heel to heel. It is necessary however to prepare the foot, before the leather is put on, and the best way of doing it is to smear the whole lower surface of the foot and frog with common tar; gas-tar must be especially avoided, as it dries and hardens the horn, instead of keeping it moist and promoting its growth, as common tar does; then the hollow on each side between the frog and the crust, from the point of the frog back to the heels, should be filled with oakum dipped in tar, and pressed down until the mass rises somewhat above the level of the frog on each side, and gives it the appearance of being sunk in a hollow. A small portion of oakum may be spread over the sole in front of the frog, but none must be put on the frog itself excepting the bit in the cleft, which is necessary to prevent dirt working in from

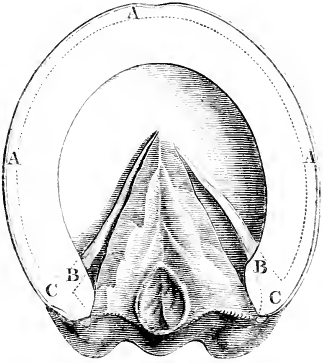

Fig. 9.

behind. The best way of dealing with this bit is to pull some oakum out straight, twist it once or twice, fold it in the centre, then dip it in tar and press it into the cleft, and carry the straggling ends across the frog, to mix with the mass on the side of it. Oakum is a much better material for stopping the feet than tow.

The usual mode of stopping the feet is to take a large wad of tow and spread it over the whole of the sole and frog in one mass, which is most objectionable, inasmuch as it causes a constant pressure on the frog, which is just what the stopping, to be at all useful, should prevent. Fig. 10 shows the stopping, properly placed in the foot, and fig. 11 shows the appearance the same foot would present when properly shod with leather.—Just as I had proceeded thus far with my subject, I received a letter from a gentleman in the north of Devon, containing the following anecdote, and as it bears on the matter I have in hand, I will at once record it. He appears to be a zealous advocate for the system of shoeing I have recommended, which I gather from his letters, for I have not the pleasure of his acquaintance. He tells me that a short time ago he sent his bailiff to a sale some ten miles off, and directed him to take a very hot pony he possesses, which had never been previously used excepting in the plough: this pony was shod with only four nails in each fore shoe, and he cast one of them by the way. The bailiff took him to the nearest forge and told the smith to put on another, and at the

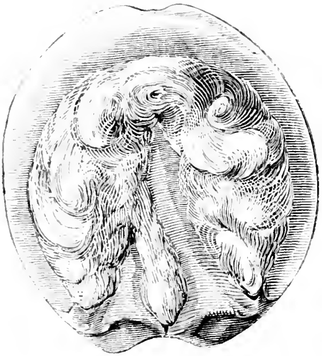

Fig. 10.

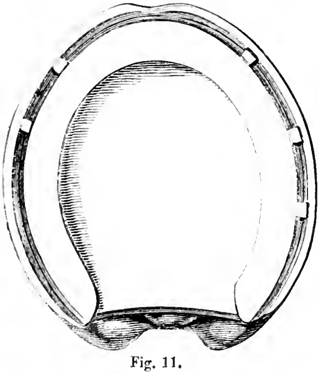

Fig. 11.

same time called his attention to the way in which his shoes were made and put on. His reply was, "I never saw a horse shod like this; it will never do for this country; no wonder he cast his shoe: but I'll put one on my way, and I warrant he won't throw that." Accordingly the shoe was put on, nailed inside and out with eight nails, and two or three days afterwards the pony went to plough again in some stiffish clay for an hour or two, and when his work was finished it was found that he had left his new shoe behind him somewhere in the clay, but the other shoe, with four nails in it, was safe on his foot.

The fact is, that a larger number than five nails are never required excepting for the purpose of counteracting defective fitting, and in this case the fitting was clearly so bad that even eight nails could not hold it, although placed in the small shoe of a pony. I may mention here that a few days ago my groom picked up a shoe in the road with nine nails sticking in it, and I was struck with his observation on finding it. He said, "if this had been one of our shoes, Sir, with only three nails in it, there would have been a pretty talk about it; but as there are *nine*, no one will say anything about it:" and I have no doubt of the correctness of his conclusion, for human nature is prone to be very tender over the misfortunes of long-cherished prejudices, but merciless in its visitations on the failure of any attempt to correct them.

The hind foot is differently formed from the fore foot, and requires to be differently shod; nevertheless, the same principle of fitting the shoe to the foot, whatever its shape may be, bringing in the heels close to the frog and placing the nail-holes so as to permit the inner quarter and heel to expand, applies with equal force to the hind as it does to the fore shoes. One of the great mistakes smiths fall into in shoeing hind feet is squaring the toe, and placing a clip on each side of it, with a view, as they say, of preventing the horse striking the toe of his hind shoe against the heel of his fore shoe, and producing the disagreeable sound, called "forging;" but as a horse never does forge with his toe, the plan of squaring it and the reason assigned for it equally fail in their object, and, like many other fallacies connected with the art of horse-shoeing, produce the very results they were intended to obviate.

A horse forges by striking the outer rim of each side of the hind shoe, just where it turns backward, against the *inner* rim of the fore shoe, just behind the quarters; therefore the broader the toe of the hind shoe is made by the squaring and the clips, the more likely the horse is to strike it against the fore shoe. It happens in this way: the horse fails to carry his fore foot forward quickly

enough to get it out of the way of the hind foot, and the toe of the hind shoe is thrust into the opening of the still held up fore shoe, and the outer edge of the hind shoe strikes against the inner rim of the fore shoe and produces the sound. I have entirely cured several horses of forging by merely causing the corners of the artificially-squared toe to be removed and the toe restored to its natural form.

The best mode of treating the toe of the hind shoe of all horses is to make it rounding and rather pointed, and to turn up a small stout clip in the centre: the toe should be tolerably thick, as the wear is always great at this part of the shoe, and the back edge should be rounded with a file, particularly for horses at all likely to be put to fast work; it prevents the chance of "overreach," which, like forging, is often erroneously attributed to the front of the toe, but is invariably caused by the back edge, which in a half-worn-out shoe becomes as sharp as a razor. The accident is very properly named, for the horse really overreaches the fore foot with the hind foot, and the back edge of the toe of the hind shoe in its return passage to the ground strikes the soft part of the heel of the fore foot, and often produces a wound that is very troublesome and difficult to heal.

The only other portions of the hind shoe which require special attention are the heels, and in dealing with them we must depart widely from the principle I have hitherto advocated of following nature as closely as possible. We are compelled to have recourse to art, not however with a view of assisting, much less with a view of improving, nature's contrivances, but for the sole purpose of counteracting what, it must be confessed, is to a large extent a necessary interference on the part of man. Nature made horses with flat heels, but she put no sharp bits in their mouths; she left them free to choose their own time for stopping and their own mode of doing it; but as soon as they are subjected to the control of man, his heavy hand and sharp bit pull them up without warning, and without the smallest reference to the position they may chance to be in at the time, or indeed without reference to anything but his own sudden impulse. We must therefore do all we can to guard the poor horse against the numberless strains and injuries incident to his changed condition, and the best mode of effecting it is to raise the heels of the shoe, and keep the natural heels as far from the ground as is practicable without throwing the foot too much on the toe.

The plan I have adopted for many years past is to have the heels forged longer and deeper than is commonly done, and when the ragged ends have been cut off, the heels are made red hot, and

the shoe placed in the vice with the heels upwards and projecting; the smith then hammers them down, to shorten and condense them, until the mass is reduced to about an inch and a half in length; he then removes the shoe from the vice and makes the top, bottom, and sides of the heels flat on the anvil, preparatory to fitting the shoe to the foot, taking care that both heels are of an equal height. This plan affords a larger and more even surface of support than mere calkins would do, and is better for fast work; but calkins are very useful for heavy draught, provided they are made of an equal length at each heel. Nothing is more distressing to a horse than working in shoes that bear unevenly on the ground, twisting and straining his joints at every step he takes.

Some horses have a habit of striking the foot or shoe of one side against the fetlock joint of the other side either with their fore or hind feet, and various devices have been at different times suggested as a remedy for the evil; but as each horse has his own mode of doing it, much difficulty is often experienced in hitting upon the right one. I have frequently solved the difficulty by placing a boot, or piece of cloth covered with damp pipe-clay, over the injured part, and then causing the horse to be trotted along the road, and he generally returns with some of the pipe-clay adhering to the offending portion of the opposite foot or shoe, as the case may be, pointing out pretty clearly the part to be lessened or removed. The adoption of this simple plan has saved many a horse from months of torture arising from ill-contrived shoes and misapplied remedies.

As a general rule, horses' shoes should be removed once between each fresh shoeing; but this, like all general rules, admits of exceptions, for if a horse wears out his shoes in less time than a month, they had better not be removed, or if he has a weak, brittle hoof, and does not carry his shoes longer than five or six weeks, they had better remain untouched, as such feet grow horn very slowly, and are rather injured than benefited by frequent removal of the shoes; but a horse with strong feet, who carries his shoes over a month, should have them removed and refitted at the end of a fortnight or three weeks, dependent on the time his shoes are likely to last.

The treatment, or I might almost call it the ill-treatment, that horses' feet receive in the stable requires a good deal of revision, and might very well commence with the all but universal custom of washing the feet and legs with cold water the moment the horses return to the stable from their work, when they are often heated, tired, and exhausted. Nothing can be more injudicious than subjecting them to the sudden chill, caused by a liberal application of cold water to their legs and feet at such a time, and then

leaving them to dry as best they can. The amount of cold produced during the process of evaporation is so great, that the poor beasts remain in a state of chilled wretchedness for many hours before they become thoroughly warm again. If their legs and feet must be washed as soon as they return from their work, let it be done with water that is quite hot, and let them be rubbed dry immediately; they will then feel warm and comfortable, instead of being cold and miserable; but as many stables are not provided with hot water at command, the best plan is not to wash them at all when they first come in, but merely to pick out the feet, clean off the dirt, and leave them for several hours, until the circulation has recovered itself and subsided into a natural state, or even until the following morning, when they may be safely washed with cold water, and the delay will do no harm.

Horses' feet are generally kept too dry in the stable; they all require moisture, and the best way of applying it is to surround the hoof by a wet swab, and keep it on for a few hours during the early part of the day, before the horse has been to work, but it must never be put on after his return from work. The feet should be stopped at night, and the best thing to do it with is fresh cow-dung, without any admixture of clay; when clay is added, the heat of the foot dries it, and the stopping becomes hard and does the foot more harm than good. Many persons, to save themselves a little trouble, substitute horse-dung for cow-dung; but they would do well to forego the whole of the trouble, and not stop the foot at all, rather than use horse-dung for the purpose.

It is a very good plan to smear the hoofs, sole, and frog all over with some emollient dressing every morning, as soon as the horse has been cleaned and got ready for the day; it need not interfere with the use of the wet swabs, which may with advantage be placed over it. I have used the following preparation for many years in my stable, and have found it to be very efficient in preserving the natural covering of the hoof in a good healthy state, and, as a necessary consequence, the horn beneath it elastic and tough:—To a pound and a half of lard add a quarter of a pound of beeswax, a quarter of a pound of common tar, and a quarter of a pound of honey; melt the lard and beeswax together, and then stir in the tar and honey: they require to be stirred for some little time, until the mass begins to set. I am informed that the addition of two or three ounces of glycerine will prevent the mass becoming too hard, and I have no doubt, from the peculiar oily properties of glycerine and the numerous purposes for which I find it is used in surgery, that it would prove a valuable addition to the hoof-dressing. What is required is some covering that shall pre-

vent the escape of the natural moisture of the hoof, and at the same time be emollient, adhesive, not too fluid, and free from any irritant.

Various causes have combined during the last few years to enhance the value of horses of every description, and it has become incumbent on every one, whose attention may have been particularly called to the subject, to communicate any information his experience and careful observation has supplied him with, and which he believes may be of use to his neighbours, by arousing them from the state of apathy into which many of them have permitted themselves to fall concerning a matter of so much importance to them commercially and personally as the soundness of their horses' feet.

Dixfield, December, 1857.

XI.—*On the Manurial Properties of Clay from Gas-Works.* By the Rev. W. R. Bowditch.

Increase of population demands a corresponding increase in the production of food, or a proportional rise in price of the quantity produced. In thinly-peopled countries the extra demand is met by the culture of fresh land, and no necessity exists for raising the acreable produce of that in cultivation. But when the soil of a country which will pay for culture is already productive, the only mode of increasing the quantity of home-grown food in that country is the obtaining a larger yield per acre by improved culture. The basis of all remunerative agriculture is manure, and though we hear much of the sufficiency of atmospheric nitrogen and read elaborate arguments on the growth of forests and prairies, practical farmers of all classes know that the produce, and therefore the profit of their farms, depends chiefly upon the liberal supply of good manure. Proof of this is found in the readiness with which guano was purchased and used, and the steady perseverance in the use of this valuable manure, despite high price and unprincipled adulteration by second-hand dealers. No future historian will write the history of the first half of the nineteenth century without devoting a page to the multiplication of food due to the introduction of guano, and eulogizing the readiness with which a great people paid millions a year for the excrement of birds from barren islands in the Pacific.

The high price of guano, and the offer of the thousand pounds prize by the Royal Agricultural Society, have given a great

impulse to searches after new substances or new combinations of known ones which can compete with guano, and the result has been an enormous increase in the manure list, without much real addition to the available and economical fertilizers employed by farmers. It is beside the mark to point out the reasons of this, though it may save some disappointment in future, and perhaps direct effort more usefully, if one principal cause of failure be indicated. Most experimenters have laboured without fully realizing the problem to be solved. "A substitute for guano" has signified to them *a manure weight for weight* equal to the substance of which it was to take the place, and which could be sold for half or two-thirds the price. If there were no other absurdity, here is a violation of a first principle in political economy. If their new substances were equally efficient with the one against which they competed, they would be worth the same price to the farmer, he would be ready to pay the same price for them, and the producers, as good men of business, would never think of selling at any lower price than the competition of guano compelled them. The real question was, "How can I add to the acreable produce of Britain by the discovery of a manure which shall be a positive addition to all known manures, producible in such quantity as to be a national benefit, and at such a price as to leave a good profit to the farmer who uses it?" This mode of viewing the subject might have rendered men benefactors to their country, who have now wasted energy in seeking what is unattainable.

The results communicated by this paper are derived from investigations carried on without regard to any subordinate view of the problem to be solved. The question was considered in its totality, and unknown or useless substances have been converted to a known and beneficial use. Farmyard manure consists of the remains of a present vegetation, part of which has been animalized by passing through (perhaps forming part of) the bodies of animals. This manure does not support the life and minister to the growth of vegetables until it has been decomposed into new compounds, and the conditions under which nature has intended it to yield the substances fit for plant nutrition are all fulfilled when the manure is buried in the earth.

Guano is the excrement of birds, most of which probably feed on fish, that is, vegetation altogether animalized by becoming part of or passing through the bodies of animals. This ministers to growth when it is mixed in proper quantity with the soil, and not otherwise, for plants placed in guano die as certainly as when placed in fire. Although this manure is so much more concentrated by animalization that it has a market value fifty-six times

as great as the former,* the circumstances under which it promotes growth are precisely similar to those in the other case. Yet if the substances contained in farmyard manure and those contained in guano be placed side by side in parallel columns, none but chemists would recognise the same fertilizing elements in the grand total of such dissimilar substances.

Coal is commonly regarded as the remains of an extinct vegetation, which has been subjected to slow oxidation under enormous pressure. It contains about 1·75 per cent. of nitrogen, equal to 2·125 of ammonia, while farmyard dung, in its ordinary condition, contains about ·64 per cent. of nitrogen, equal to ammonia ·78.† The latter is equal to 14·3 lbs. of nitrogen per ton, or 17·4 lbs. of ammonia, while the former equals 39·2 lbs. of nitrogen, or 47·6 lbs. of ammonia. If coal would decompose readily, we need only lay it upon our fields to give them all the elements of the highest fertility. But inasmuch as it will lie almost undecomposed for scores of years, its treasures are locked up, and some process of disintegration must be resorted to before they are available. Burning is a process of this kind, but so enormously wasteful as to be intolerable were it not that the formation of manure is a subordinate, and the production of heat the principal object sought by the combustion. The soot deposited in our chimneys is a valuable fertilizer, containing variable quantities of different ingredients, of which the most important to agriculture is sulphate of ammonia. Johnston found 35 per cent. of this substance; but I have never met with so large a quantity, and suspect that 12 per cent. is far nearer the average.

Distillation, as practised at our gas-works, is also a means of disintegration, in which case so much nitrogen is volatilized, that nearly all the salts of ammonia in commerce are derived from this source. The ammonia produced is carried down with the condensed tar and water produced in the distillation, and no advantage to agriculture appeared likely to result from attempts at improvement here. No attempt, therefore, was made to touch what was known and available, but it was from the gas *after* deposition of tar and ammonia that a valuable addition to our known fertilizers was sought and discovered. Distillation does not volatilize the whole, or nearly the whole, of the nitrogen of coal and ammonia, but converts a large part of it into other compounds, which have long been the pests of gas-consumers, and which have a high value to the farmer. Moreover, much of the ammonia produced was not removed by the ordinary means of purification, but passed on with the gas to the destruction of

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* Guano = 14*l.* per ton; farmyard dung = 5*s.* per ton; 5*s.* × 56*s.* = 14*l.*

† R. A. Society's Journal, vol. xvii., p. 194.

fittings and the production of compounds which cannot be discussed here. It is enough to observe, that all ammonia and every other nitrogen compound supplied in gas was so much loss of food and money.

Having determined the source of supply, it became necessary to find means for making it available. To prevent the recountal of experiments which do not bear upon the great question of adding to our food-producing power, it may suffice to say that clay presented itself as likely to fulfil all the conditions which must be satisfied in the solution of this problem. Numerous investigations had made me familiar with its properties, and I expected that it would abstract from gas, and retain firmly, the elements of fertility which it was desired to obtain without injury to the illuminating power of the gas, and at a cost which would render it practicable on any scale. The purest available clays were first tried, but experiment soon showed that any clay or aluminous earth would accomplish the purpose thoroughly. Then arose the great difficulty: were the substances thus absorbed suitable for agricultural use? Might not some one or other render all else useless? Nothing short of trials in the field could answer these latter questions, and yet theory and known facts afforded a strong probability that all the substances absorbed by the clay were suitable plant-food. Ammonia, its carbonate and sulphate, which were all absorbed by the clay, or produced as the result of subsequent decompositions, were well known and valuable fertilizers, and all doubt about these was at an end; but the same could not be said of sulphocyanide of ammonium and other metals which the clay took up and retained in considerable quantities. But still it was difficult to believe this compound to be injurious. Sulphocyanic acid is found in the saliva of man and the sheep, and must either be taken in the food as such or produced in the body by the vital processes, which furnish a considerable number of the analogies of substances obtained from the distillation of coal. Mustard-seed, again, is known to contain the sulphocyanide of allyle. Horseradish and Alliaria officinalis contain the same substance. The garlic and common onion contain an oil which differs but little from that of mustard, &c. With these examples of analogous compounds in the animal body and in vegetables, there seemed little risk in applying sulphocyanides in quantity.

A trial of this manure on half an acre of onions, sown July, 1857, strikingly shows its beneficial action upon this crop. The whole plot was well-manured in the ordinary way, and about four-fifths dressed with this in addition. Where this was put, the crop was fully double that on the part left for comparison. A wholesale dealer in such articles purchased the crop on the

land and assured me, as did also his workpeople, that they pulled between two and three times the weight of onions off the same area of the part on which "the blue stuff" was, compared with what was pulled from the part where it was not applied. He sells the onions *by weight* to the West-Riding House of Corection at Wakefield, and is, therefore, much more competent to form an opinion than one who merely judges of what he sees, though the difference is plain to the most casual observer.

Many compounds of cyanogen produced by the distillation, and retained by the clay, found corresponding ones in the urea and uric acid of urine and guano, the hydrocyanic acid of bitter almonds, peach kernels, the leaves of the cherry laurel, &c. when distilled, and other compounds of both kingdoms of Nature, which it is beside our object to discuss.

At present, however, any attempt at producing analyses to account for visible effects, and saying thus and thus these substances act, hence and not elsewhere or otherwise the fertilizing power is obtained, would be, in my opinion, unpardonable presumption. The analyses must be explained by the phenomena, the phenomena must not be tortured to fit the analyses. I have hitherto withheld the results of much labour on this ground, and propose to learn from, and not to impose interpretations upon, Nature. Chemistry is honoured by becoming Nature's handmaid—it is made contemptible when put forward as her guide. Meanwhile some of the practical results obtained by the employment of this most complex manure are sufficiently remarkable to demand and repay attention.

The first attempt to use it in the field was made in 1854, and the results were almost entire failure. One farmer put enough for two acres upon less than half an acre and sowed the land with swedes. I warned him of the result if he departed from the directions given him, and am told that he had three small turnips upon his half acre. Another person shot up a cartload upon some grass and left it there for days, and for two years that spot was as bare as a turnpike-road. It was moreover applied with a shovel to growing vegetables in a kitchen-garden, and they gradually dwindled away or died almost at once, according to the dose they happened to receive. This kind of thing excited the strongest prejudice, and one farmer who laid it on his grass by shovelfuls and destroyed every blade, declared that it was fit for nothing but to ruin the crops. Annoyances, arising from mere disregard of directions, were so many, that I strongly advise those who attempt to prove any thing new to refuse a supply to every person who will not undertake to use it rigidly as directed. Had not the truths taught

by theory in this case been pertinaciously adhered to against what, by a misnomer, some would call experience, British agriculture might have been deprived of a boon, which it is difficult at present to estimate.

It would be tedious and useless to chronicle all the failures, and half-failures, and successes which attended the early use of what I desire to place before the Society, and I will therefore confine myself to such cases as are either remarkable or characteristic. The first notable use in 1854, was by the gardener of the Wakefield Union Workhouse. He had served his time at the Earl of Mexborough's, had been upwards of twenty years head-gardener at the West Riding Lunatic Asylum, and was very fond, as the local phrase goes, "of trying experience." He obtained gratuitously (as did any one who wished) a supply of the new compound from the gas-works, and applied it to some early turnips which he happened to be sowing. This was the very application which theory would indicate. Here was the most sulphurized of all manures being applied to the most highly sulphurized of our field crops, and though this was done on a piece of poor soil in a garden and on a variety of turnip not generally raised for farm purposes, still the experiment was quite as satisfactory as it would have been on the half acre of swedes of the wilful gentleman before-mentioned. The question put was, "Will excess of sulphur in manure promote excess of growth in turnips?" and the answer could be given as distinctly by a few rods in a garden as by the largest field in a farm. The crop was inspected by many, who all agreed that they had never seen it surpassed. The leaves were half as broad again as a man's hand, and the bulbs corresponded with the luxuriance of the tops. Parallel to this may be mentioned an experiment made in 1856, which I heard of by accident, and which was made, it is said, for the purpose of showing the worthlessness of the new manure. A person (whose name I have not obtained permission to mention) obtained a supply and took it to the farm of a relation on the estate of the Duke of Leeds in Nottinghamshire. It was employed for both swedes and white turnips, four rows of which were sown alternately in the same field, against the bare soil, farmyard dung, and what is called "management." I suppose this signifies hand-tillages, but am unable to say with certainty. The experimenter visited the farm in October, and was amazed to find the turnips, which were manured with the saturated clay, the best on the farm. This result was of course not mentioned, but at length it slipped out in the ardour of conversation with three other persons, and has since, I am told, been mentioned to several others.

I am not unaware that many, perhaps most farmers, will urge

that the ammoniacal salts and other compounds of nitrogen promoted this luxuriant growth of turnips, and that the sulphur played but a subordinate part. Chemists, unfortunately, lend their authority to the opinion, and assert that soils always contain an abundance of sulphates, and, therefore, farmers need not trouble themselves to add sulphur. But is this so? May not the superior action of dissolved bones, superphosphate, and similar compounds be due in a great measure to the sulphuric acid they contain, and not simply to soluble phosphate which does not exist in the soil, or insoluble phosphate "in a fine state of division?" I confess myself strongly of opinion that the sulphuric acid is a very potent agent in bringing about the good results which are so familiar from compounds in which it is used, and when we recollect the raising of a crop of turnips by watering the drills with dilute sulphuric acid only, and the other successful experiments collected by Johnston ("Experimental Agriculture," p. 104-5), I cannot help attributing the success with turnips, above described, as much to the sulphur compounds as to the compounds of nitrogen. Does not the known efficacy of woollen rags as a manure point in the same direction? I know of course how large a proportion of nitrogen they contain and how this is usually dwelt upon, but is it considered that they contain an amount of sulphur which is capable of forming 12½ per cent. of their weight of anhydrous sulphuric acid, and that the hop, for which they are almost a specific, contains a sulphurized oil nearly, if not altogether, similar to the oils of mustard, garlic, onions, &c.? When nitrogen compounds can be purchased more cheaply than at present, other ingredients of manure may perhaps receive closer attention than they now obtain. The extreme importance, and increasing price of nitrogen, has pushed it somewhat beyond its true position.

Cognate with what has been said already of turnips, and of sulphur as an element of their growth, is the question of sulphurized compounds as a manure for grass. Confessedly the first agriculture in the world is that of Britain. The able and impartial testimony of M. Lavergne may well make every farmer proud of the body of which he is a member. But though pre-eminent it is not perfect, and even farmers confess that the state of grass land in England is a reproach which they would gladly wipe away. Hence the struggle on the part of tenants to break up, opposed by (as I think) the wise determination of landlords to retain, permanent grass. But why does the blot exist? What brought, and what can remove it? With all the aid which modern enterprise and discovery have rendered the farmer, by placing at his disposal many valuable additions to his home-made manure, it is a fact which needs no

proof that nearly throughout the United Kingdom the utmost effort can barely give an adequate dressing to the arable land which requires it. Nor need it be proved that the management of grass has generally been to feed or mow continually with hardly a return, till the diminished produce compelled something to be put on, if it were only lime, road-scrapings, and ditchings. This is not charged upon British farmers as a fault, for I have no doubt that it was inevitable, but it need not occur again, for an annual supply of manure can be produced at home, which will suffice for every acre of the three kingdoms, and in a few years will double the produce over the green acres which adorn our land, and which will then be the farmer's glory instead of a reproach. All the nitrogen of wool and hair came originally from the soil, and most of it from grass. The five millions of pounds of sulphur on the sheep's backs of this country were principally derived from grass, and if we assume an average of $1\frac{1}{2}$ ton of hay (or the equivalent of grass) per acre, and 7 per cent. as the quantity of ash, no less than 235 lbs. of mineral matter are removed with every crop of hay. Deterioration was the only thing which could arise from years of removal without return, and it is time that we adopted a contrary course and raised the fame of our meadows and pastures to a level with the peerless fame of our ploughed fields. Experiments of many months' duration, which would be out of place here, show that the gas-works of Great Britain are capable at present of producing nearly or quite 600,000 tons of manure per annum, of which $\frac{3}{4}$ of a ton is a sufficient, and a ton an abundant dressing per acre. Upon *pastures* I should myself use half a ton mixed with a ton of earth, road-scrapings, &c., and by a systematic annual application, should have no fear of doubling the return now yielded by the grass.* This would set free for the root crops all the manure produced upon the farm, and all which is now purchased, and would thus improve the means of keeping cattle, and therefore of growing corn. The experiments upon which these opinions are based extend over three years, and have been made upon various kinds of soil, but the principal portion has been upon the clays of the coal measures.

In the winter of 1854-5 a small quantity was used on about half a rood of a 10 acre meadow by a farmer named Turner, of Stanley, near Wakefield. The application was made without my knowledge. This field had been mown annually for four or five years and had never received any manure, and previous to that time it had had a heavy dressing of soot. It is generally wet,

* If this were done in December or January to the grass intended for early lambs, a supply of early feed would be obtained which can be procured by no other process within my knowledge.

save upon some slightly rising parts, near which I understand two or three drains were inserted some years ago. The spring of 1855 was exceedingly dry, and the field was generally very brown on the 1st of May, when I cut excellent green succulent grass 6½ inches in length from the plot to which the new manure was applied. In the winter of 1855-6 the same farmer dressed the whole of the meadow, and obtained so remarkable a crop, that the field became a place of resort and surprise to most of the small farmers in the neighbourhood. Upon the rising portions the grass was laid like corn, and was so thick that it was rotting in the bottom when mown. The aftergrass was sold for 30*s.* per acre to an adjacent farmer, named Harrison, who keeps much stock, and who informed me that he never saw sheep and cattle thrive faster than they did upon that aftergrass. A larger *quantity* could not have been produced upon the land.

Some instructive facts were noted during the use of this manure upon grass, which seem to show that plants take up their food in the same state as that in which it is presented to them; and that, like animals, they may be gorged to repletion and die of excess of food, which they are unable to assimilate. A blue compound of cyanogen and iron, analogous to Prussian blue, has been mentioned as existing in the saturated clay in considerable quantity. When a plot of broccoli was manured with the manure which the gardener at the Wakefield Union Workhouse had obtained from the gas-works, I was surprised to see the plants grow well and yet gradually become blue. The colour was quite different from the blue of stagnation from drought and poverty, which is often seen in cabbages; and the fact of these broccoli plants growing vigorously while they gradually became more and more blue, negatived the supposition that here was nothing but a familiar phenomenon. Feeling much interest, I watched the matter closely, and was amused at length to see the whole become as blue as if the leaves had been painted. The fragments of the gas refuse lying upon the surface among the plants showed the origin of the colour, and the question to be solved was, is this temporary or permanent? Will the absorbed substance prove food or poison? A short time showed that, though taken up in its integrity, decomposition was proceeding, and in about a fortnight the blue had changed to that dark luxurious green which always accompanies an abundant supply of salts of ammonia. This brought to mind some experiments on celery, in which the like taking up of more manure than could be assimilated was accompanied with rapid growth and apparently perfect health. In one case, common salt was applied in enormous quantity in a wet season, and during any dry intervals the plants were freely watered. So much salt

was taken up that the green extremities of the leaves tasted strongly during all the period of growth. The only peculiarity noticed was the tendency to rot from wet when blanching. In another case soot was applied in excess to the surface of the earth only, and not to the plants, and so much was taken up that, after blanching, the celery was uneatable owing to the flavour of soot. Corresponding with these facts, we have that of weeds growing upon the sites of old dunghills which have been known to contain such an abundance of nitrates as to deflagrate when burnt. Bearing in mind these instances, I watched the grass to see if any corresponding effect was produced, and again the blue compound was taken up, the blades being dyed and passing afterwards to the same luxuriant green as marked the broccoli, while other plants died of repletion and left a record of what had happened in their blades, which were as blue as if dyed by indigo. Many similar instances have been observed since, and, indeed, any one can repeat them at will. The tendency of these facts seems to be that the blue compound is taken up by, and circulates in, the sap in an unaltered condition, and that within certain limits it does no harm, but good; and that when these limits are exceeded it injures or kills according to the quantity supplied and taken up. This power of destruction is not peculiar to the substance as such, but is shared equally by guano, urine, sulphate of ammonia, and other concentrated fertilizers, and when the plant appropriates such substances as nourishment and converts them into the material of its own structure, it arranges them in some new and suitable combinations.

When this blue compound was taken up in an unaltered condition I had serious doubts about the suitability of grass thus grown for feeding purposes. These doubts were shaken when Mr. Harrison said of Turner's grass that "the feeding quality was as good as the quantity was large;" though, as the manure had then been applied to the field for six months, and the blue compound could not be seen in the leaves, I regarded the testimony as far from conclusive. All doubt, however, is now removed, for upon a part of one field dressed with the saturated clay this year I saw the grass eaten as bare as if the land were shaved, while there was abundance of grass on other parts; and Mr. Bennett of Horncastle, who applied his manure in March last to a single acre in each of two fields, writes me "that cattle are much fonder of grazing on the portion of the field dressed thus than on the other part." I shall not presume to question animal instinct, but the result is the very opposite of what was to be expected from the fœtid compounds employed in the dressing.

During the winter of 1855-6 the manure taken from the purifiers of the Wakefield gas-works was thrown into the open yard, where

it laid exposed to snow, rain, wind, sunshine, and all the countless changes of our most changeful climate. About thirty tons were fetched away by a farmer on the 30th April, 1856, and shut up in an open yard as freely exposed as before. Much ammoniacal and other gas was given off, as a plot of potatoes proved which was about forty yards distant, for all the foliage was destroyed when a north-east wind brought the gases across the plot. Part of the heap was removed to a pasture, where the course of drainage could be traced for more than a hundred yards by the destruction of the grass. In January, 1857, the heap had been subjected to the full influence of weather for upwards of twelve months, when part of it was used to manure the ten-acre meadow before mentioned. Opinions were freely expressed on the impossibility of an artificial manure retaining any virtue after such treatment, and the use of a substance thus dealt with was certainly an experiment of the highest agricultural interest and importance. The result is, that the grass of that field dressed with this alone grew luxuriantly and too early, for it was nipped by the biting east winds and sharp night-frosts which prevailed so long in the spring, and that now (May 30th) on the dry parts of the field is growing the most abundant crop of grass which I have seen this year. If not mown early, it will be laid as the grass of the same field was last year, and, in the case of wet, will rot in the bottom.

The "potato-disease" has an interest for every one, whether he be a producer or consumer; and as an experiment of last year bears upon the subject it should be known. I planted 3 acres of Prince Regent potatoes, to $2\frac{1}{2}$ acres of which a quantity of this new manure was applied, mixed with the heap which would otherwise have been used alone. Half an acre had none. The heap was badly mixed, so that in parts there was a large excess, and in parts hardly any. Time prevented a second turning, and it was used with all its defects. The whole crop grew well, and no great difference was apparent for a time. At length the disease appeared badly in all the district, and after a time the tops became diseased and died away. I sold the crop on the ground to a dealer, who, as well as his men, assured me that where the "blue stuff" was there was no disease, or, if any, very little; while, where none of this could be found, the principal portion of the crop was affected. To test their assertions, I requested them several times to dig up portions of the crop in various parts of the field, and found that the statements they made were entirely corroborated. I was prepared for the better crop which accompanied the special manure, but its influence over disease was entirely unexpected. I think also it is unexplained. *If* the disease be owing to the attacks

of a fungus, and *if* sulphur in some or all of its combinations be a preventive, and *if* carbonic acid and arsenic (both of which exist in small quantity in the clay) prevent its attacks or its growth, we may account for the prevention in this particular case; but where the whole subject is so entirely beyond the limits of our present knowledge, it appears more becoming to hesitate in the expression of opinion. What is certain is, that the attacks of disease, and of course the presence of a fungus, could be traced down the stems below the earth to the tubers, where it stopped when these were in contact with the gas-manure, and to which it extended in all other cases. But an isolated instance does not prove that we have here a specific against disease, nor even that the action of the same agent will be the same on other soils and under other circumstances. Trials alone can do this, and trials in sufficient number to warrant an induction. What happened is interesting and suggestive, but I could not advise any one on this ground alone to employ the manure for his potato crop in any other than an experimental manner. If a manure for this and the following crops of a rotation is required, the question is altered; the blue clay may be applied with confidence where the object sought is fertilisation, and not insurance against disease.

Perhaps I may be excused for indicating in conclusion the position I should like to see occupied by the stranger whom I have introduced to British agriculturists. Its position is that of *an auxiliary*, not of *a supplanter*,—an aid to the production of more food, and not a substitute for something already employed for that purpose. The two great agricultural wants of our country are more grass and more root crops, which are inseparable from more meat and more bread; and, if permitted to have a voice in the application of the new home-produced fertiliser, I should like to see it employed as far as possible in these two species of production. The national advantage will thus be most advanced, and it will be a source of satisfaction to feel that, while the general good has been promoted and increased support provided for our pressing population, a benefit has been conferred upon an interest which is at the basis of national prosperity, and upon a class of men who are second to none in the qualities which make good citizens.

St. Andrew's, Wakefield, December, 1857.

XII.—*Time of Entry on Farms.* By the Rev. WILLIAM HOLT BEEVOR.

PRIZE ESSAY.

THE comparative advantages of entering upon a farm in Spring, and in Autumn, depend mainly upon the nature of the farm. The Dairy farmer obviously would prefer to enter upon his new taking at a season when he would have the summer grass before him, with the opportunity of raising turnips and beet-root for the winter.

For entering upon a farm altogether or nearly all arable, Autumn undoubtedly is the season, as there is the winter before the in-comer for preparing the land in a way that he cannot expect from the outgoing tenant except under the rarest circumstances.

To the Pastoral farmer, whose occupation is the rearing of sheep and cattle, it is of the same clear advantage as to the dairy farmer to enter upon the houses and the grass at Lady-day, so as to have the summer before him for grazing, haymaking, and the growing of root-crops.

What we have to consider, then, resolves itself to the question of entering upon a farm of mixed husbandry, which embraces *all* sorts of farming practised in the country, and which is at once the safest and the most usual mode of farming. In this case also we are of opinion that it is decidedly more advantageous to the new tenant to enter in autumn than in spring.

When we speak of entry in the spring, we mean an entire entry; as when we speak of an autumnal entry, we mean an entire entry upon the farm at the separation of the crops.

The most *convenient* mode of entry is, doubtless, to come into the houses and grass at Lady-day and to the land at Michaelmas; or, what is much the same thing in all essential points of view, to the houses and grass at Whit-sunday, and to the land at the separation of the crop from the ground.

What I regard as the question set for consideration, is that of the comparative advantages of an *entire* entry in spring and in autumn. In this consideration, I give a decided preference to an entire entry in Autumn, at the separation of the crop from the ground, rather than an entire entry in spring, at Candlemas, or Lady-day. Much depends, of course, upon the different customs and practices of different counties; such as whether there be allowed compensation for unexhausted improvements to the outgoing tenant, and what length of time; whether too the straw, hay, turnips, &c., can be sold off the premises, or are left by covenant to the in-coming tenant under certain reasonable conditions.

Upon the whole, however, we decide in favour of the superior advantages of entering in Autumn rather than in Spring, and for the following reasons.

I.—Autumnal Cultivation.

Because, in the first place, the in-coming tenant can secure that due culture of the land he has taken at the decline of the year, which is so strongly advocated by Mr. Pusey, and is becoming one of the most important questions of agriculture; to which is due the diminishing of the cost of the turnip-fallow, and the introduction of supplementary crops in our rotation, after the example of the indefatigable and thrifty Flemish farmer. He can be sure of the good treatment his land has received, in the way of being prepared by deep ploughing for the beneficial influence of the frosts; in being also fairly manured, instead of his having to accept the account, often so unfairly made up by the outgoing tenant: as for instance, there are cases when 100 loads of manure have been sometimes charged for which should rather have been 25,—dishonest conduct, of which there is too often no evidence to convict the offender. In some counties this knavery has attained to such a pitch that there are men who make it a business to take a farm for the sake (in the language of Surrey) of "working it up to a quitting," and clearing a good balance on their removal to another holding.

By entering in the autumn, the new tenant has moreover the opportunity of adopting that eminently successful plan of improved agriculture, the laying the manure upon the young seeds, —a practice which his predecessor might not have chosen or thought fit to adopt. This, as much else most expedient for the successful treatment of land, the outgoer would find himself too much occupied to attend to, as there is a hurry at the last, even if he were inclined to do it. He has thus too the advantage of being able to plough the stubbles up directly after harvest, and of thoroughly exterminating those insidious sprigs and joints of couch-grass, which spread and strengthen rapidly when the crop that previously oppressed their growth is gathered.

"Do you hoe your crops much by horse or hand in the spring?" we remember once asking one of the most successful and neatest farmers in the United Kingdom. "Neither," was the reply; "I clean-pick the fallow so thoroughly in autumn that I have no weeds in spring, and a harrowing sufficiently stirs the soil and lets in the air; while much valuable time is saved at an important season." What a melancholy sight is the green stubble, so fondly patronised by the old-fashioned farmer,

whereon the couch is encouraged to grow as late keep for his flock, by whose dung it, in turn, is fostered to be the pest of future cultivators! How much more tidy, as more profitable, is it to have the stubbles pared and burnt immediately upon the removal of the corn; the surface knocked about with heavy harrows, the ashes covered, and a crop of white turnips drilled in with 2 to 3 cwt. of superphosphate per acre, to be eaten on the ground; or, at least, they may be ploughed in preparation for turnips the next spring, and this, on light soils, is no mean gain; for to work a light soil to its proper fineness of tilth wholly during the spring is found to deprive the land of its due moisture, and so render it unfavourable to the growth of the turnip-braird; whereas, if it be worked in autumn there is secured an abundance of moisture.

This theory gains great support from the almost universal complaint of the Suffolk light-soil farmer against a clause usually entered in the leases of that county, which obliges him to work his land five times over, even though "it be a blowing sand," when one turning over is found by unfettered tenants ample, and productive of crops, the very semblance of which cannot, under the other system, be attained.

If a dairy form any part of the new tenant's scheme of operations, it will be of vast service to him to be able to put a dressing of bone-dust on his pastures in time to be covered over by the late growth of the year; so wonderfully does this manure conduce to the improvement in quantity and quality of the dairy produce; its effects, when once apparent, being found to last seven, fifteen, to twenty years, though not immediately perceptible; it is advisable, for the sake of an earlier return, to apply the dressing at the earliest possible period.

Again, by ploughing for himself, instead of paying the outgoing tenant for his work, the young farmer will save at least what, in butchers' language, we may term "the fifth quarter;" for that a profit is looked for, and not merely the cost price, is certainly the rule.

II.—The Crops.

There is, in the second place, a great advantage in the new tenant having his own arrangement of the crops upon the farm for the ensuing year. It may suit his purpose or his fancy better to adopt a different course to that adopted by his predecessor,—a subject admitting of so great a diversity of opinion now in these days of chemical analysis and artificial manures. We presume him, of course, as every enterprising farmer should be, unfettered

by special restrictions, and left rather to his own judgment and fair disposition than subject to the peremptory dictation of his landlord as regards the treatment of the soil to which he looks for his livelihood and credit.

Seed.—By entering upon his farm in autumn he has also the opportunity of selecting his own seed-corn, instead of being obliged to trust to the honour and discretion of the outgoing tenant, and so can, with some confidence, look forward to a prosperous harvest. And this is a far greater advantage than it might seem at the first blush; for, trifling as the saving on the amount of seed-corn would comparatively be to them, while the result to their successor is ruinous, still there are men mean enough to defraud the in-comer of his due in that respect.

III.—Store Cattle.

Our next argument in favour of an autumnal entry is that, supposing, in this instance, the practice of Oxfordshire and other counties to hold good—viz., that a crop of turnips be left by covenant upon the land, while the hay and straw are allowed to the in-coming tenant at a third below market price—supposing this practice to hold good, or that the new tenant has had the opportunity of securing roots, hay and straw, at a fair price, he will have a great advantage in being able to buy store-cattle and sheep at autumn rather than spring prices. It is, in Suffolk, the general practice to buy in, at the fall of the year, a lot of shorthorns, polled Galloway Scots, and Irish cattle, to be house-fed, fattened and sold in spring.

In Buckinghamshire, again, the farmers purchase ewes during the autumn to lamb in January and be sold off fat in summer. Thus, during the dark winter months, he may turn over profitably a portion of his capital while he has the opportunity of clearing his way for the spring operations.

IV.—Farm-Horses.

His farm-horses too he may purchase at a considerably lower figure in autumn, when the harvest work is over, than he can in spring. At that time they rise in value on the approach of active field-work, and are often not to be bought at all, unless at a high premium. The difference in the price of farm-horses in spring and autumn, coupled with the profit the in-coming tenant will reap from ploughing his own stubbles, I consider more than equal to the cost of their winter-keep and attendants' wages.

V.—Manure.

He will also have the chance of being rewarded in the spring by the possession of manure sufficient for his use by keeping all his animals in sheds and yards, instead of having to incur a serious outlay in guano, nitrate of soda, superphosphate, &c., at a time when he has ample calls upon his capital. It is not to be expected, at any rate, that, in succeeding another, he should have the same quality of manure left as he would have made himself; for an outgoing farmer, even if he adopted the plan of feeding in yards, would scarcely supply his stock with the same amount of cake and corn when he knew that he was not to reap the benefit of it in the manure: an argument that gains new weight from the prospect we have now of a failure in the guano supplies, while as yet no convenient substitute has been suggested. We have greater faith, we confess, in dung than in guano, the benefit the land derives from it being infinitely more lasting. What a comfortable appearance has a lawn thick carpeted with straw-manure, as we lately saw at the Prince Consort's model farm, and what promise of abundant sweet herbage does it afford! To meet the objection of those who urge the great expense of hauling out the manure from the yards and on to the land, we reply, that if the farmer keep the remunerative class of horse he should, he may always have a few spare young ones for occasional use, which will pay their way, if selected or bred judiciously, as well as any of the stock about the place, while he has meanwhile had the benefit of their labour, the exercise contributing to their health and condition.

VI.—Draining.

If draining be required on any part of the farm, though it is the province, strictly speaking, of the landlord to do it, whether free of cost to the tenant, or whether receiving a percentage on the outlay, as the hauling of the pipes falls upon the tenant, it is of advantage to him to have the winter before him for the work. Besides that, not only are draining operations carried on at the most favourable season in autumn and winter, but there is time for the filling-in to settle and the sod to be rolled down in anticipation of the necessary spring treatment of the land. Whereas, if the draining be only commenced after the tenant has come into occupation on February 2nd or March 25th, owing to the usual difficulty and delay that attends the securing an efficient gang of drainers, it is often with the greatest difficulty, after the most strenuous exertions—if, indeed, it is possible at all—to

get a crop of hybrid turnips off the land, be the season ever so favourable.

There are few farms deserted, or from which the tenant is removed, where you will not find that some land, at least, requires, as is the phrase of Yorkshire, to be "boned and bled:" that is, to be drained, and afterwards have a dressing of crushed bones at the rate of about 2 tons an acre,—an operation that answers infinitely better when the autumnal growth gathers on the deposited manure—and which thus improved will afford keep for an additional cow to every four acres.

To quote Mr. Caird:—

"The best time for laying on this manure is in autumn, early enough to admit of a fresh growth of grass to cover it before winter. On seeds which are intended for permanent pasture, it should be laid on after harvest. Its effect is to cover the ground thickly with clover, trefoil, and succulent grasses, in lieu of the thinly planted and very innutritious pink pointed grass which previously occupied the soil. Some farmers told us that it had doubled the produce and improved the quality of their cheese."

VII.—Scouring Ditches.

There is profit, again, in the young farmer being able to have the ditches properly scoured, instead of their being half done by the outgoing tenant, or left altogether, from stress of work, till the second year of his occupation.

Pools may be emptied and repaired on farms where water in summer would be scarce; and this—considering how foul such watering-places are allowed to become by a careless tenant, either from carrion being thrown in, or from the fall of decayed leaves (especially the deleterious leaf of the ash-tree), from the cattle standing and scouring in them, or from the yard-drainage having an outlet into them—is a matter of no mean import. Many are the disorders of cattle and horses which arise from their being allowed to drink at pools of this description. Farmers often argue that their cattle and horses *prefer* such a mixture to the clearest river or pond-water: in fact, because it is grateful to their stomachs, disordered by bad food and treatment; just as you will often see a horse eat soil at the hedge-side. Change their food, put rock-salt in the manger, and, if necessary, give medicine. You will no longer find that they prefer to fill themselves at the pool on the lowest side of the farm-yard, into which the dung-juice drains. The poultry-fancier knows that on the purity of the water supplied to them depend the health and plumage of his stock. It is as well that farmers too should know that staring coats and broken wind are the certain ultimate conse-

quences of allowing their teams to drink such turbid stuff. At the bottom of foul pools, besides many other noxious reptiles, there accumulate the larvæ of a large species of beetle, which, swallowed by the drinking animal, are productive of the worst results, causing them to void blood, and greatly reducing them in flesh and strength, if indeed they recover at all.

Liquid Manure Tank.—Entering in autumn, the farmer can have made at once—whether of clay, as recommended by Mr. Dickenson, or of masonry—one or more of these useful appendages to a farm upon which the fertility of the artificial grasses depends so greatly; pipes being laid from the cow-sheds, stables, and piggeries, as well as from the centre of the straw-yard, the surface of which should be sloped from each side down to the mouth of the drain in the middle, just as stalls for geldings are paved.

Water-Meadow.—When water is abundant, a rivulet convenient, and the land lying low, an energetic man has it in his power at once to form that most valuable adjunct to a farm, a water-meadow, before the November rain sets in and the season of irrigation comes on; while the fences he may pull down and burn, together with tangled sods of the old banks, will afford a top-dressing of ashes, found by Mr. Pusey so beneficial at the first laying out of his celebrated catch-meadows.

We suppose, of course, the case of a man following an ordinary tenant of the old-fashioned class, that is satisfied ever with what is and has been, and never dreams of improvement. Under any circumstances, however, an active mind will always find room for improvement, every man having his own mode of operation, as he has distinct features and a distinct genius.

All this, and much other work best done in autumn and during the winter season, will have to be done, we must remember, by the in-coming tenant under exaggerated circumstances. It is certainly the exception when a man gives up a farm in fine condition and a cleanly state. More usually the case is, that from circumstances of discontent, or disaster, or shortened means, the outgoing tenant has removed; or perhaps under notice from his landlord. It is not, therefore, likely that the land and premises will be left in a highly desirable plight. When a farm is surrendered contentedly, we may fairly conclude, as a rule, that there is a son or relative ready to step into the outgoing tenant's place, which would make it a matter of comparative indifference whether he came into occupation in autumn or spring. On the whole, then, I am led to the full conclusion that it is more advantageous to an in-coming tenant to have entire entry in Autumn than in Spring.

To sum up in a few words. A farmer who has come into pos-

session at Michaelmas is, in fact, when February arrives, in the position of one who has been long resident upon the ground. He is on terms with his land, and has the satisfaction of being a year sooner in the thick of the fight.

The only substantial argument in favour of an entire entry in spring, is the fact that a farmer can then start *with less capital:* that he will have quicker returns, and be enabled to drift on to the winter, when, if he be enterprising, he will undertake what I have mentioned above as fitting improvements. One year's advantage of those improvements he will, however, lose by the side of a farmer of equal enterprise who has had entire entry in the autumn.

The most convenient mode of entry for farmers generally is, we repeat, to the houses and grass at Whit-Sunday, and to the land at the separation of the crop from the ground.*

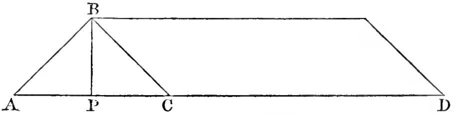
The contents of dung-heaps, clay-heaps, &c., are easily calculated thus:—

1. Find the mean area, *i.e.* ½ the sum of the area of the top and the area of the base.
2. Find the mean depth, *i.e.* the sum of several depths divided by the number of the depths taken.

The mean area multiplied by the mean depth will give the solid contents.

In the case of dung-heaps, when the base is rectangular, the area is easily found by multiplying the length and the breadth together, and the solid contents are found thus:—

Fig. 1.



Note. × means multiplied into.

(1.) If the form be as in Fig. 1, where the breadth A C and the length C D are known:

The contents of the heap $= \frac{1}{2}$ A C × B P × C D, in cubic yards.

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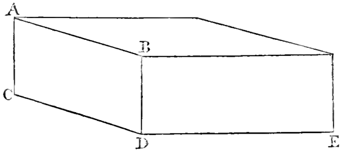
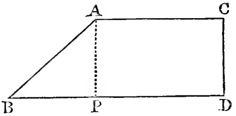
* There is one rather important point connected with the Michaelmas entry not specially adverted to by the author. It is, that at that season of the year the land tells the tale of its productive powers, and of its condition in point of cleanness, in a way which the practised eye cannot very well mistake, or be misled in. The grain is *all* seen in stack, and was probably seen by the in-comer on the ground: the stubbles are open to the eye, and between harvest time and Michaelmas-day exhibit their state *and tendency* in reference to the weed-crop, if any. In fact every crop is off the ground; the plough and the harrow have as yet concealed nothing, and the farm is, so to speak, naked to inspection. The argument of less capital required for the spring entry is clearly temporary and fallacious, and, rightly viewed, is an argument against it.—C. W. H.

Fig. 2.



(2.) If the form be as in Fig. 2:
The contents = A C × C D × D E
= the product of the height into length into the breadth, in cubic yards.

Fig. 3.



(3.) If the dungheap be against a wall, and of form Fig. 3:

The contents of the part A P C D may be measured as in the case of Fig. 2, and the contents of the sloping part A B P as in the case of Fig. 1.

It is easy then to find how many cubic yards a cart will hold, and the calculation is finished when you know the value of a cart-load according to local estimates.

Measurement of Haystacks.

A simple method is given by Mr. Stephens, which, from stress of time, as the principle is constant, I borrow:—

"To the height from the ground to the eaves add one-half of the height of the top above the eaves for the mean height; then multiply the mean height by the breadth, and their product by the length. Divide the gross product by 27, and the quotient will give the number of cubic yards in the stack; and that number of yards multiplied by the number of stones of hay in a cubic yard will give the weight of the stack in stones imperial. It is not easy to state the exact number of stones of hay in a cubic yard, as they must vary according to the compressed state of the hay in the stack, the age, size, and part from which the hay is taken determining the degree of compression, which varies as much as from 5 to 9 stones; but perhaps 6 stones may be near the mark in a new stack, 7 in one that has stood some months, and 8 in one a year or two old. [This applies to an oblong stack.]

"The contents of a round stack with a conical top is thus measured: Take the height of the round part from the grouud to the eaves, and add to it one-third of the perpendicular height of the conical top above the eaves for the mean height of the stack. Take the mean girth, which is found by taking the girth at the eaves and at the ground, and dividing their sum by 2. Square the mean girth, and multiply the product by the decimal ·0795, which will give the area of the base of the stack. Then multiply this area by the mean height,

which will give the contents of the stack in cubic feet; divide the contents by 27, which will reduce them to cubic yards; and multiply these by the number of stones in the yard according to either of the above suppositions, and the capacity of the stack will be found in imperial stones.

"To know the contents of a conical rick, take the girth at the ground in feet, find the area of the circle by the above method, and multiply the area by one-third of the height. The contents thus found in feet reduce to yards, and then multiply by the number of stones in a cubic yard."

Hints for Use at the time of Entry.

Without attempting any exact specifications on this subject, I venture to add a few hints of a general nature, founded upon a recollection of my own particular need upon a like occasion.

Sale Purchases.—When a man commences farming he will find it his interest to purchase good new harness—good, without any elaborate ornamentation merely to please the eye. I was puzzled upon this very point at the sale of my predecessor's effects, but luckily allowed the old and patched-up trappings to be bought by a neighbour, at prices apparently advantageous. Comfort came at the close of the year on a comparison of our respective saddlers' bills.

Machinery.—Let the young farmer purchase too his machinery of the newest make; for in these days of rapid mechanical progress, implements get cheaper often as they get improved; and though there are some which in the course of time are marked by no novelty of construction, it too often turns out that machinery, bought apparently a bargain, second-hand, is really dear. In fact, as a general rule in life, and not only in farming, it is best to start with good substantial machinery of the newest approved fashion. It is always the cheapest plan in the end, and often not the dearest to begin with, if proper judgment be used in the selection, and resort be had to a manufacturer of credit. Carts, waggons, tedding-machines, ploughs, harrows, &c., except on rare opportunities, you will not find, unless damaged or of an inferior kind, at a farm sale. For myself, I am thankful that, on the strength of a friend's suggestion, I bought but little at my predecessor's sale, and much of that little disadvantageously; as I could obtain better implements, of more useful modern make, at about the price those old ones cost me. So well aware are the manufacturers of this, that in Leeds there are houses that sell off their machinery every ten years, as they consider the advantage they have in competition with new machinery will more than balance the loss they must incur in the exchange. A tenant removing to another farm, if prudent, will take his best things with him, leaving only the refuse, with odds and ends

contributed by neighbours for their convenience, to swell the sale of what he mainly looks to, the crops and stock.

Fixtures.—As regards agricultural fixtures in the strict sense of the word, by an Act passed 14 and 15 Vict., cap. 25, it is enacted that—

"If any tenant of a farm or lands shall, after the passing of this Act, with the consent in writing of the landlord for the time being, at his own cost and expense, erect any farm-building, either detached or otherwise, or put up any other building, engine, or machinery, either for agricultural purposes or for the purposes of trade and agriculture (which shall not have been erected or put up in pursuance of some obligation in that behalf), then all such buildings, engines, and machinery shall be the property of the tenant, and shall be removable by him notwithstanding the same may consist of separate buildings, or that the same or any part thereof may be built in or permanently fixed to the soil, so as the tenant, making any such removal, do not in anywise injure the land or buildings belonging to the landlord, or otherwise do put the same in like plight and condition, or as good plight and condition as the same were in before the erection of anything so removed: Provided nevertheless that no tenant shall, under the provision last aforesaid, be entitled to remove any such matter or thing as aforesaid without first giving to the landlord or his agent one month's previous notice in writing of his intention to do so; and thereupon it shall be lawful for the landlord, or his agent on his authority, to elect to purchase the matters and things so proposed to be removed, or any of them; and the right to remove the same shall thereby cease, and the same shall belong to the landlord; and the value thereof shall be ascertained and determined by two referees, one to be chosen by each party, or by an umpire to be named by such referees, and shall be paid or allowed in account by the landlord, who shall have so elected to purchase the same."

By this most useful and comparatively recent Act, the interest of the landlord is promoted, at the same time that great encouragement is given to the enterprise of an intelligent and earnest tenant. With such fixtures, being permanent improvements, the in-coming tenant should in fairness have nothing to do. There being, however, landlords so short-sighted as to throw all they can upon the in-coming tenant, rather than allow the outgoing tenant to remove what may be essential to, or at least greatly favour, the due working of the farm, it will be well for the in-comer to take such fixtures at a valuation made by unbiassed parties. This we suppose to be done upon the security of a long lease. Upon such a question, however, the in-coming tenant should never have to decide. Such a so-called fixture as a chaff-cutter, which, in the right sense of the word, is no fixture at all—a machine that, on a 100-acre farm, will save its prime cost in a winter—if in fair condition and good working trim, it would be advisable for the in-coming tenant to retain, as he might have some difficulty in replacing as aptly a tried machine—that is, if he can retain it at a fair price. A thrashing-machine, engine, &c., corn-bins, dairy-fittings, &c., being fixtures in the right sense of the word, it belongs to the landlord to deal with.

Experienced Friend.—Under all these difficulties let the young farmer get an experienced and elder friend to make his arrangements for him—at least to be behind the curtain in consultation with him on the occasion of this his first independent start in life. The novice is apt to be shy, and give way in bargaining lest he be considered mean and covetous (an infirmity of which the man of the world too well knows how to take advantage): and although, were he acting *for another* under like circumstances, he would not scruple, nay rather be proud, to fight that battle for the right which unhappily lies mostly on contested ground; in the case of his own affairs he is apt to be timid, and so "finds too late that men betray." For the rough work then of starting, let the young farmer commission some experienced friend, and wait with calm mind for the result.

Caution.—The young farmer is too often hasty and eager, and there are too many outgoing tenants, as well as landlords, who will nail an incautious engagement or unguarded word. To "keep your own council" is safe policy. There is never any good done, but often much mischief, to your plans by blabbing ere you carry them into execution. You are at least certain of being tormented by the unsolicited opposition and advice of a dozen busybodies, who watch you but to canvass and criticise your proceedings when your back is turned. Such, being professed gossips, will shrink away gradually from a demeanour of studied reserve; so that you will have the satisfaction of developing your own undertaking in its bloom. Half the credit of life has its clue in this policy. What a cutting censure on such people was the designation of "the bigot's hole," given by Sir J. Conroy to an open box upon a drain in one of his fields which he was held to ridicule for draining too deeply, through which the water might be seen pouring at any moment.

Judgment.—General good judgment is required in farming, as indeed in all other pursuits and professions wherein a man would attain to eminence and wealth; and this is shown chiefly in the doing the right thing at the right time, and the having the right man in the right place. For instance, it would be wasteful to employ your men in cutting firewood or breaking stones for the repairs of the farm roads on a dry fine day when the swedes required drawing, or the wheat-field was shedding its seed.

Forethought.—Again, you should be always looking ahead, or rather, as a celebrated elocutionist used to teach his pupils—"Keep one eye on the passage before you, and one upon the future."

Look out Yourself.—Never leave any important provision to be made by your men. It is no more their place to be concerned about that branch of the farm duties than it is expected of the

county chief-constable to take his turn upon "a beat." Not in harvest-time only, but always, the master can do far more with his eye while cantering over the fields, or strolling leisurely through the yards, than by the actual labour of ten pair of hands. For instance, you know by your book when the different cows should calve. See that there be ready gruel, and a horn to give it, so that a search has not to be made at the last moment; with a well-aired loose box, and a dose of salts and ginger to follow a few hours after parturition. The meanest particular should not be neglected: it was by such minute foresight and careful circumspection that "the Duke" won his great name. You will find in his Despatches, after mention of the most important business, an allusion to some myrtle plants he had been requested to procure.

Many an accident comes of a cow's being allowed to calve tied up; not to mention the additional torture the poor animal must derive therefrom in the moment of her agony. See, too, that the udder be tried each morning and evening by the herdsman, when it has once begun to spring, and duly milked as it begins to fill: so will many a cow be spared garget and milk-fever, which might otherwise have spoiled or carried her off. See that she have no turnips or cold water near, to gripe her after salts. Precautions such as these constitute a main secret of the farmer's success.

Upon this theme read the eloquent language of Mr. Caird, while speaking of the eminent Shorthorn breeders on the south side of Teesdale:—

"Men are still," he writes, "to be found there who have been bred from their childhood to study the peculiarities of form and symmetry, which, combined with early maturity and great weight, have given the improved Shorthorn its celebrity. Seldom leaving home; often the first to see their stock in the morning, and the last to visit them at night; making the health of each individual of the herd a study; and enabled, by constant attention and particular management, to encourage the development of such points as they think requisite; while everything else on the farm is made subordinate to the stock—these men have acquired a fame which is the result of such earnest application, and cannot long be maintained without it."

Your eye should be ever on the move to mark that the foals' paddocks have no rabbit-burrow improvised, as they often will be in a night; no open drain or loose stones about, whereby to strain a fetlock; no pitchfork or bucket left carelessly beside the shed; no nails or broken bottles lying about; no open hurdles, wherein to entangle and break or strain a leg; to see that their hoofs are regularly trimmed, and no incipient sand-crack allowed to spring; to observe that no gas-tar be daubed near the brood-mare's box, nor any other offensive smell be allowed which might produce abortion; that no alder-tree be near for her to crop, with an effect equally fatal to your hopes; to see that there be abundant litter

in the sheds, so that the young colts' hocks do not get capped in rising from their beds, and that it be fresh to tread on, and not foul and fermenting so as to produce thrushes; to see, too, that no cow be moping or shivering over her food; that there be no yew cuttings or garden refuse about to poison your herd or pigs. All this, and much more, it should be the farmer's care to notice. Once every day at least, and those who love their farm will never tire of the task, should all the stock be gone over, every animal carefully inspected from heel to horn. It is marvellous how common men, even those who love their horses and their herd, day after day will allow a lame cow or sick horse to go toiling on in misery. "'Tis the master's eye that makes the horse fat," says the old Greek proverb: not that the men will often defraud their horses of their corn; I have never known personally an instance. But the regular cleaning, the early feeding, the comfort, the keeping warm, the ventilation, must be looked to by the master, or there will some day be neglect.

Time and Locality.—To catch the wave at its turn is the secret of farming, as of everything else; to select that which will pay best in the shape of crops and cattle, considering your locality, and to adopt the course that will make it pay the best. This in Essex and South Lancashire is especially neglected. In parts of Lancashire, where, as Mr. Caird remarks, the very flowers at the cottage door might be made a source of profit, still agriculture is backward and the farmer desponding. In Warwickshire, again, the opportunity of dairying near towns is thrown away. The neighbourhoods, again, of Portsmouth and Southampton are blind enough to allow these places to be supplied with potatoes from France. On the other hand, we remember visiting the residence of a gentleman eminent for his ingenious agricultural discoveries no less than for his prize poultry stock of various breeds. It was an instructive study to notice the simple contrivances by which he had made the back-yard of a small suburban London house serve his purpose to the utmost as a farm-yard. Not less instructive was it to hear the history of his success; how in one year he had cleared 700 guineas by the sale of Cochin China fowls; how, when he noticed the taste to be subsiding, he had sent to Holland for the best Spanish fowl that could be procured, and at that time their breed was far superior to anything in England; how, again, when opportunity offered, he had fed the market with carrier-pigeons imported from Persia direct. Surely a man of that stamp must deserve to win. Success must, indeed, eventually crown the honest exercise of practised intelligence and industrious exertion. An instance in point is the following:—

I remember to have read years ago of a farmer, I think in Kent, who, after an unusually disastrous failure of the hop-crop,

was induced to try some cuttings from a plant that grew upon a hedge-row in the neighbourhood, which he had observed to thrive when the cultivated grounds presented but a scene of ruin. He succeeded; his plants soon rose to a high premium; he kept up his price, and finally realised a large sum of money. His hops became the favourite sample of the London market. I mention the fact as an instance of the value of that intelligence and quick eye, which I recommend the young farmer most strenuously to cultivate from the first moment of his entry upon his farm. The simplest circumstance will supply to a mind thus trained the germ of a grand discovery.

As Napoleon is said to have gathered his first idea of the celebrated Code Napoleon from the casual study of a volume he picked up when once placed under arrest as a young man—Justinian's Institutes I believe the work was; and as Nelson laid the foundation of his great fame as a pilot in the Baltic while employed as a midshipman to sound the windings of the Thames; so did the project of Bell's reaping-machine occur to him as he was amusing himself with a pair of hedge-clipping scissors in his father's orchard. In fact, as great inventions are usually of the simplest kind, so do the most trifling circumstances suggest them to an observant mind. Let the young farmer, then, look out; let him travel to get acquainted with stock and places and men of authority in agriculture; there are landlords in England who will pay the expenses of a tenant travelling with that view, so well do they know the ultimate benefit such a course must bring to themselves—the tenant—and so perhaps eventually to the noble science of agriculture itself.

Whoever aspires to be distinguished in any pursuit or profession must have his eye and ear ever on the alert to select the wheat from the chaff of knowledge that is thrown out, as well in books as in the conversation of the so-called "men of the world." The points of useful information he should note, and never afterwards forget; there is no knowing at what time they may be inquired after in the market of life. Witness Sir Joseph Paxton, who was picked up as an under-gardener at Kew, by the Duke of Devonshire being struck by his unusual intelligence: the man who subsequently, amidst the hubbub of a railway board, of which he was a member, sketched upon a piece of blotting-paper, the world-celebrated plan of the Crystal Palace. Witness, again, George Stephenson, whose first essay in life was his undertaking to clear of its flooded contents a coal-mine which had been despaired of by more practised hands. The proprietor casually overheard him express an opinion that he could drain it, as he stood in sorrow amidst the crowd of lookers-on. Stephen-

son accepted the challenge thrown out to him, cleared the mine in a shorter time than could have been imagined, and from that day was a made man.

To return, however, to the more direct line of our instructions, the best hint that can be given to a young in-coming tenant is, to start forthwith in the determined prosecution of the field-work, autumnal or vernal, most especially required at the season. (See 'Calendar of Operations.') We presume him, of course, acquainted with the practical details of all farming operations; in other words, we presume him to have passed his agricultural apprenticeship; for to enter into such an explanation would be to fill volumes, not an Essay. The best advice to a young tenant, then—his stock, implements, &c., having been purchased—is to "take time by the forelock," and to start with what most requires doing at that particular season. He should not be clipping fences (though that in its place shows good farming) when the weather allows and there is land to be ploughed. As the credit of the mason depends upon his selection of the fitting stone, and the true line in which he places it, so does the success of the agriculturist depend upon his judicious decision of what is to be done next, and his seeing that it is properly done. A few rough general hints I will subjoin here, without regard to their connection, as that can little matter.

Old Pastures.—Beware of breaking up old pastures, even if corn be dear as in Pharaoh's time, and though you have your landlord's leave. Pasture for milch-cows can never be too old; and if you fancy it has grown feeble you can always refresh it by harrowing in the spring, some manure, and a dose of "renovating seed." To break old pasture up is to kill the goose for her golden eggs. Many is the farmer in Gloucestershire that bitterly rues his precipitation in adopting that plan.

Selection of Implements.—Catalogues, with full details and amply illustrated, are now so easily obtained by post from any one of the numerous makers, whose advertisements appear in the pages of the Agricultural Journals, that the young farmer will have no difficulty in making a good selection. Let him, if he have the opportunity, consult some intelligent modern farmer. Too often, however, he will not have this opportunity, or his friend may be loth to advise. In this case let him weigh carefully the respective merits of the different implements as described and drawn in the catalogues, if he have not had an opportunity of visiting some one of the great shows, where the makers are always to be found, and he will readily be enabled to select what he wants. Economy, however, let him strictly observe; at the same time that he should be forward to purchase every imple-

ment that is really of service to aid or shorten labour. A good sound article let him purchase of the plainest form consistent with substantial neat workmanship. The man who studies for himself is far more likely to be well suited in the end, and at a lower rate, than he who consults merely the show-room, on market days, of the local dealer in agricultural implements, who is naturally anxious to dispose of what he has on hand, and who is not always a man of enterprise or an unbiassed witness.

Buy as you want for your immediate use, and no more—for instance, on entering your farm you must have horses, harness, carts, ploughs, harrows, &c., store cattle, and sheep, proportioned to the turnips and other keep, either left by the outgoing tenant by fixed covenant, or secured at a fair price : the cattle and sheep being sold fat in the spring at a good profit, will provide you with funds for the purchase of spring tools ; a roller, crusher, &c. &c., in aid of your stored capital. My idea is, that no farmer can do justice either to himself or his landlord who has not *ample* funds to commence with, so as to be able to provide himself with the best of all he needs ; while by paying ready money he not only has a check upon his expenditure, but will save the value of a cow or more in discount allowed for cash payments.

I am perfectly aware that it is the too-frequent practice to start in the agricultural line with limited means, or at least such as are just equal to a partially fair but not first-rate treatment of the soil. This practice cannot but be blamed, beside the practice of those who measure their taking by their purse, and leave themselves an ample balance in hand. Exceptions there are, of course, to every rule ; but, generally speaking, what we advise is the safest and most satisfactory plan. Whatever be the extent of the lease the true policy of the in-coming tenant must be to grapple with his land as soon as possible ; to have his vessel trimmed and fully manned before he leaves the harbour, and not start with an insufficient complement, intending to pick up an extra hand or two at the various ports where he may chance to touch.

Cash Credit.—A justifiable means of increasing your capital, where your prospects are pretty safe, is the obtaining what bankers term a 'cash credit' at your local bank. This a young man of character will always be enabled to effect ; he will always have some respectable friend or relative whose security will be accepted at the bank for what extra money he may require up to a fixed mark, say 50*l.* to 500*l.*, according to his need. For this accommodation, which has been the means of making many a young man in business and farming, a certain rate of interest will be charged, with a commission to cover the necessary incidental expenses. Meanwhile the young farmer pays in his receipts

and draws for his need within or up to, but not beyond, the fixed limit; until, in time, if he be prudent, as he should be, he will have the means to clear himself of the obligation. A *cash credit* is, to all intents and purposes, additional capital, and the person using it holds an intermediate position between the man who takes a farm, to which the insufficiency of his means does not allow him to do full justice, and the more enviable owner of an ample independent fortune.

The cash credit system, within moderate limits, is by no means an unsafe one for a reasonable and prudent young man to avail himself of.

Bills.—For the system of giving bills we cannot say as much; it is too well known to need any explanation, and, as it is a system which I should recommend the young farmer firmly to avoid, I shall pass it by without further comment.

Jobbing at Sales, as a means of tiding over the difficulty of entering upon a farm with insufficient means, may be fairly deemed a discreditable and dangerous practice, which it requires more judgment than the young farmer generally possesses to render profitable. It is looked upon with suspicion by those whose good opinion is worth obtaining, as being too often nothing else than a cloak for absolute bankruptcy.

Seeds.—Select for seed-corn the best sample you can find, even though you have to pay a few extra pounds for it: when harvest comes you will be more than amply repaid. For your other seeds, mangold wurzel, clover, turnips, rye-grass, &c. &c., employ some respectable seedsman, the ample details of whose catalogue you may leisurely study; or, if you be at fault, state simply to him your need, and he will select for you perhaps better than you could do yourself. For any seeds but seed-corn trust not the skill of your neighbours, for you will probably have to pay far more than you would to a man who makes the ripening of seed his special vocation; whose character and interest are staked upon the quality of his supplies. A frequent cause of the failure of the clover crop is undoubtedly the use of seed imperfectly ripened at home.

Insurance.—Insure at once all your stock and crops, or rather effect an insurance of what you calculate will be about two-thirds of the value of the regular crops and stock upon the farm; it will be a comfort to yourself, as it is a duty to your family. As a corollary to insurance, it is a good plan never to allow a light in your stable, or, if there must be one, let it be inclosed in a good lantern, as servants in this respect are too sadly careless. By no means, under any pretence, allow smoking about the premises.

Local Traditions you will often find useful. What suits one

description of soil or climate will not answer in another. Every country has its variety of local practice, which the scientific farmer will be able to decipher, and adopt the best parts of. Study, therefore, and learn to listen patiently to an account of local usages and practice, which may serve you well some day in combination with your otherwise acquired general farming knowledge. Drury anticipated years ago, by the use of common sense and observation, many points of agricultural practice which have since been put upon the base of science.

Purify Premises.—At entry, have every stable and cow-house, every rubbing-post and shed, thoroughly cleansed of all possible infection by a good washing with a solution of chloride of lime. You may so escape many a dangerous or troublesome disease, such as glanders, scab, &c., the seeds of which would otherwise have been lurking for an opportunity of communicating their contagion.

Thin Sowing is by some, as by Mr. Mechi, warmly advised; by others, as by Mr. Beasley, condemned, because

"corn should not be encouraged to tiller. If the plants are sufficiently thick in spring they at once send up the stalk; but if the roots are thin they send out lateral shoots, which strike in the earth and produce new plants. The first plant is weakened by having to produce auxiliary plants, and the plants of the second growth do not come to maturity so early as the original or parent plant. The quality of the crop is thus injured, as there are always more light and defective corns in a thin-sown than in a thick-sown crop; besides that there is less seed to meet the contingencies of wireworm, grub, or very severe weather."

Hoeing on a light soil increases tail-wheat, and without immediate rolling to follow there will be a great deficiency of crop. Others are of opinion that hoeing cuts the small fibres of the wheat and lets it fall. I have adopted with success Mr. Beasley's plan of sowing at intervals of 4 and 14 inches, making 18 inches between the two outside rows, exactly as when the rows are 9 inches apart; thus—

4	14	4	14	4

The 14-inch intervals are thus caught and cleaned by the horse-hoe, while the plant escapes all risk.

Wages.—Pay your workmen on Friday in small silver; the poor fellows will then not have to enter a publichouse or shop to obtain change, where they are always expected to spend some portion of their weekly pittance in return for the accommodation.

Capital.—Turn your capital over continually; small and frequent profits you will find the surest source of wealth.

Manure Heaps should always be covered by a shed, having moreover upon each layer as it is added a coat of earth or salt to prevent the escape of the ammonia, termed by Mr. Huxtable so aptly "the spirit of the farm." They should stand in a paved hollow of about a foot in depth, or much of the best part will sink down into the ground. We have found the dark rich stains six feet beneath the surface when the dung-heap had been laid upon the bare ground. If there be no pipe from the centre of the hollow in communication with the manure-tank, it is an excellent plan to have the paving laid after the fashion of a "well-dish;" the liquid to be thrown over the heap with a scoop as it gathers in the well.

One ton of straw, under skilful management and ordinary circumstances, should make three tons of manure: the average yield of straw being 1½ tons to an acre, there will consequently be 4½ tons of manure made to every acre of arable land upon the farm.

One cow housed for the winter leaves a cubic yard of manure; in summer, half a yard.

The farm-building should be so arranged that the manure from the stables, cow-sheds, and piggeries may be thrown upon the same heap and mixed at once, the quality of the heap being improved and tempered by the admixture. It is a good plan to put a layer of sawdust, ashes, mixed earth and marl, the charred clippings of fences, tanners' refuse, in fact, anything absorbent, beneath, to catch the drainings; and when this cannot be done we recommend the "well-dish" plan.

When, by a thermometer plunged in, the heat of a dung-heap does not exceed 100°, you may know that the fermentation is not excessive, and that there is not much gaseous matter disengaged and lost.

Lime.—Almost the first piece of unsolicited advice with which his old-fashioned neighbours will present the young farmer, is the recommendation to "lime his land." Liming in their estimation is a Holloway's pills remedy for all disorders and infirmities a farm can suffer from; and many is the unhappy field that has been stimulated and worn to an untimely end by the injudicious adoption of this ancient panacea. There is land near Flint, as indeed in many other localities, that will positively grow nothing now, its vegetable element having been entirely exhausted by incessant use of lime. The fatal error was run into of imagining that lime *manures*, instead of it being only a means of calling into action the hitherto dormant vegetable element of

the soil. Lime does excellent service upon newly broken up land, or mixed in compost with the surface-soil of woods, or laid upon land in high condition.

Lime mixed with manure will rob it of its virtue. The quaint old Drury knew that long ago, though the reason of it has been left to modern chemists to explore. The manure, however, once incorporated with the soil and its essence absorbed, if you then use lime you will lime to advantage. *Quick*-lime laid upon the surface of drained land will produce a succession of fine grasses, in lieu of the coarse bent and carnation grass that clothed it before. *Newly slaked* lime, at the rate of 2 tons an acre, harrowed in with the wheat, is found effectually to prevent the attacks of grub and wireworm.

Contrary to what might be expected, soils over limestone are often especially benefited by a dressing of it, in a caustic state. Mr. Nesbitt gives a simple rule for discovering whether any particular soil requires liming or not; that is, to procure some of the earth of different parts of the field, and drop some spirit of salts upon it. If it effervesce slightly, there is a sufficiency of lime present; but if no effect be produced by the application, then a dressing of lime will be advantageous to the soil. Had I known this at an earlier period of my agricultural career I might have been saved much thought and trouble.

Much else might be given to the young in-coming tenant in the way of suggestions. What I have written I have drawn from the recollection of my own difficulties on entering as a young farmer; and if there be anything in what I have penned that shall encourage some youthful ardent spirit to explore the yet undiscovered seams of a glorious science, which is still in its infancy, my labour will have been amply repaid.

CALENDAR OF OPERATIONS,

Being intended rather to Remind than to Instruct.

January.—The live stock, cattle, horses, pigs, sheep, will require constant attention; good shelter, comfortable sheds, and well ventilated warm stables. Supply plenty of straw, for the better their lodging the less risk, and the greater profit will attend the management of your stock. Scatter gypsum on the stable and cowhouse floor: it fixes the ammonia and removes all smell. Whatever first-rate farmers say, we cannot believe that sheep and pigs can thrive

as well on sparred boards over a V pit, whence the fumes of their droppings continually rise, as they would kept equally dry without exposure to the ammoniacal effluvia, which makes your head ache as you walk through to inspect them. Witness the health and complexion of grooms. To scatter gypsum on the boards avails little, as is found at Prince Albert's Model Farm. Have sink-traps on all your drains. Once or twice a week dash down your stable floor with water: the sweetness of their abode your live stock will soon show by their improved condition and sleek coats. Ewes are beginning to lamb. Have a dry straw-yard ready with plenty of cabbages or mangold wurtzel in store. It answers well to dig up annually the site of your lambing-yard, and take off it a crop of potatoes for the house. Have rock salt always about in troughs for the sheep; in the manger of your cows and horses. Salt, with a few handfuls, your pig's food; it contributes to its general health, and is preventive of skin disease. Salt on their roots will save cows from being "hoven." Should a cow be hoven, the best remedy is to dose her with 2 drachms of powdered chloride of lime dissolved in 2 quarts of water: this precipitates the gas and allows her stomach to open—the trochar gives immediate relief, but she will fill again unless dosed—the knife is ever to be condemned, as the contents of the stomach bursting out after it are apt to get between the stomach and the skin, and produce disease or mortification. Curry tied up beasts; it will well repay the labour. Take advantage of frost to haul out manure on the land; the hardness of the surface saves the horses, while it prevents the land being cut up. Form compost heaps — old hedge banks, pond mud, road scrapings, ditch cleanings, any carrion available, cart together, and add a bushel of lime or salt to each cubic yard. Fetch home artificial manures. All corn stubbles and clover lea not ploughed (as they should have been) get finished off at once. On dry soils sow vetches, peas, oats, barley. You will have heavier crops, and less seed will suffice for the sowing. Sow salt over wheat, six bushels the acre: on a moist morning it will destroy the worms and slugs, while it tends to shorten and brighten the straw, increasing the yield of corn. On clay lands it is said to render the soil too moist and gives an unhealthy look to the young plant. On light soils it answers admirably. Clear water courses and mouths of drains. Cut away underwood and briars. Remove superfluous fences, mix bones and ashes, occasionally soaking the heap with liquid manure. Horse labour must be confined to road work—the carting of tiles, stones, lime, grain, artificial manures—unless during frost, when manure may be hauled on the land. Plough up grass lands. Thrash: frost improves the sample. Clear the pastures of stock which would otherwise poach them. Evaporation has now nearly ceased, so that spread manures do not suffer as much as many suppose. Keep water flowing on catch-meadows till a scum appears on the grass. Green spots mark the springs on wet land. Rear calves. Get subsoiling done in fallows and pastures, but do not flatter yourself that it will do away

with the necessity of draining. Give barley and buckwheat to poultry, as eggs will now be valuable. Last year's early pullets will begin to lay at Christmas. The French people reserve them for the purpose.

February.—Continue attention to stock. Go on with like operations upon the farm. A wet month usually. Little evaporation going on. Look to the mouths of your drains and clear away any accumulation. Give turnips freely to your young cattle, and hay: straw is bad policy. An animal well fed will ripen a year sooner. The quality of the manure depends upon the keep. Corn therefore and cake supplied in reasonable quantities is but money put out to interest. The lambs bought in autumn should be fattening on turnips, they should have a shed to run into for shelter. Sheep fatten on cut turnips and hay quicker than on whole turnips and hay with corn. Lambing ewes require constant care: above all things avoid a wet yard for them. In fact wet is injurious to any stock. Warmth, shelter, and good food will richly repay the stock master. About half the winter supply of hay, roots, &c., will now have been consumed; you can therefore judge and provide with regard to your remaining stores. Keep your fallows in ridges for the frost to exert its beneficial influence on them; they will then break like bran. Farmers generally are little aware of the manure that is supplied from the atmosphere: witness the Lois Weedon experiments. Some sow their barley now, considering that the early sown yields the best sample. Sow vetches, beans, peas, Talavera wheat. Manure and dig hop grounds. Break air holes in fish ponds to let out the bad gas which is generated in stagnant water. Sow saintfoin. New hedges should be set about, but do not top the quicks until the next spring. Lay in stock of seeds. Purchase and haul manures. Catch-meadows begin to exhibit the benefit of their winter clothing. Pare grass lands with a view to burning next month. In breaking up grass land, the safest plan is to pare and burn: if you turn it down simply, leave that operation until you are ready almost to sow. After ploughing sow and roll at once. The grubs and larvæ are then buried too deep to come up to attack the grain before it has germinated and grown out of their reach. Build walls. Form ponds. Plash hedges.

March.—Top dress your wheat. Apply gypsum (1½ cwt. per acre) to lucerne, red clover, and saintfoin, during this and next month. Stains indicate the springs on wet land now. This is the latest period at which beans, peas, vetches, can be sown. Sow barley, oats, flax, hempseed. The sowing of these crops depends much on local circumstances and climate. On "clover-sick" land put trefoil or beans as a change. Clover should only come once in 12 years on the same ground. Pick stones off seeds. Prepare potato ground to plant at the end of the month. New ground where a coppice has been grubbed up or a fence cleared delights this plant, and saves the crop, as a rule, from disease. Plant hops. Cut alders. Begin to feed water meadows. Destroy moles. Top dress

young wheats. Look carefully to your ewes. Mares will be foaling: give plenty of bran mashes and boiled beans, there is nothing like beans for producing milk. Ten days after foaling put the mare to the horse again. Kill and cure bacon in cold weather: it does not do to cure it in frost however. Sows should be farrowing now: oatmeal and steamed roots, capital food for young pigs. Cart horses must be kept in spirited condition. The first hoeing must now begin. Excellent top dressing for young wheat, 1 cwt. of nitrate of soda mixed with 2 cwts. of salt. Sow the first succession of vetches for July. Keep the roller at work on wheat and grass lands. Limewash hen-house and procure a change of eggs. Sow carrots on land deeply ploughed and manured in autumn. If your land is not so prepared, manure now and plough it in shallow: or sow land on which turnips have been eaten off. Sow flax in an adhesive loamy soil manured in autumn with well rotted dung. Give more hay with the turnips as they are apt to be laxative this month. Shut up meadows for mowing; handpick, and bush-harrow them. To drag them with harrows is capital practice; it will often double the crop if a dose of guano be given on the first succeeding wet day; without guano it will do wonders.

April.—Operations to be continued as during last month. Sow vetches at intervals of a fortnight if you fear a deficiency of the artificial grasses. Sow grasses this month with advantage. Hand-hoe wheat for the second time. Harrow old pastures and beans, preparatory to rolling when the ground is dry. Roll the spring corn if well up. Your cows should be in good order for calving. Sow red clover 7 to 8 lbs. per acre: the thicker the plant the finer will be the stems: it does better on soil manured for barley than when the manure was applied to the previous crop of turnips. Plant out field cabbages and supply well this gross feeder with liquid manure. Sow mangold wurzel to the end of this month. Check wireworm ravages with Crosskill's or Cambridge's roller. Get in the last of the turnips: if allowed to run to seed they are sadly exhaustive of the soil. Sow lucerne in drills, having trenched before if you want fine cuttings. Cut and lay fences early in the month to avoid the wood's bleeding. Roll and bush-harrow grass land if not already done. Hand-hoe wheat, beans, peas. Fat lambs fetch high prices. Sell off your porkers before the warm weather comes. Sow carrots and parsnips and subsoil the land on which you grow them. Feed off luxuriant wheat with sheep. Potatoes should be planted the last fortnight of this month. Paring and burning may proceed; spread the ashes, harrow them in, and roll. Begin to stock pastures. "The sheep pastures should have one young steer to 12 sheep. The bullock pastures one horse to every 12 beasts. The sheep pastures should be kept comparatively bare; but the bullock lands must have good bite, so that the animals may quickly feed and soon lie down to rest and ruminate. An old grazing rule is that grass should be 24 hours old for a sheep, and 12 days for a bullock." Clean out boxes and sheds and put the manure

to rot for turnips. Early this month sow guano, soot, gypsum, superphosphate, &c.

May.—Top dress spring corn: in the northern counties this is done as late as June. Cart dung to make heaps: if you suspect grub add salt. Seaweed must be ploughed in green: never put it to ferment in a dung heap. Clean beans and peas: be not afraid of hoeing in dry weather. The pulverized soil gathers moisture quicker. Sow lucerne. Fallows should by this time have been thrice ploughed; once before Christmas and twice subsequently: they should then have been well harrowed and have had the weeds picked off. Finish barley and grass-seed sowing. Pole and tie hops. Finish underground draining: whether with pipes, stones, or brushwood. Prepare land for swedes. Sow in drills and have cabbage plants ready to fill vacancies. It is a good plan to sow carrots in alternate drills with turnips: the turnip leaves do not then overshadow the soil. Keep your turnip seed a fortnight in sulphur as a preventive against the fly. Powder the young plants, also as a preventive, with a mixture of guano, soot, and road dirt. Mow "proud" wheats. Good grass this month. Sow buckwheat up to end of second week in June: it is a good change in the rotation of crops and is more profitable than barley after very late turnips to be followed by wheat: ploughed in green, it is a good dressing for the land, and is much used for the purpose on the continent. Exterminate weeds: they spread by millions to occupy the food of grain. In Australia or America, I forget which, there is a scale of fines inflicted upon those who allow weeds of various species along their lanes and hedges—a thought worthy of a statesman. Persecute incessantly the weedlings as they spring. Hoe potatoes, carrots, cabbages. Dig newly planted hop grounds. Towards the end of the month hoe and thin mangold wurtzel. Fill up blanks. Keep stirring your fallows. Soil live stock. Take sheep off water-meadows, and shut them up for hay. Do not feed them off or you will rot the sheep; and do not even soil sheep with the grass off them. Rye and vetches have been used for soiling: plough up the land as soon as cleared, and have the roller immediately after the plough to keep in the moisture. Put mares to horse that they may foal down to spring grass. This is a good time to form water-meadows. Use the winter tares and lucerne for soiling. Oak stripping commences: see that the bark is kept set up, and that there are plenty of hands, for the bark is in its prime only for a few days. Commence sowing swede turnips: the early sown produce the most certain and heaviest crops. By early sowing the plant gets in advance of its insect enemies, and time is allowed to replace failures. Plant out cabbages in ground manured and ridges, as for swedes, setting the plants from 2 to 3 feet apart. Rape and turnips for autumn keep, preparatory to wheat, should now be sown. On early soils the artificial grasses will be ready. Lucerne will afford a succession of cuttings through the summer. Handweed flax by means of women and children, who go on the land on their knees

facing the wind that the bent plants may be blown upright again. Stock grass lands. Lay in meadows. Top beans. The hedger and labourer-of-all-work should now have finished with the roads, fences, &c., and be ready to help in getting in the crops.

June.—Drill swedes in rows. Haymaking now begins. Do not leave the first crop of seeds too long growing as the second crop will suffer. Use tedding machines for hay well across the wind, which then blows the hay clear off the machine in the heaviest crop, prevents clogging, and does not oppress the horse with heat. Oil the machine well, and let it be worked at a trot: the faster and higher it flies the more thoroughly will the hay be made and the sooner ready to carry. Plough in buckwheat and vetches for manure, just as they are going out of bloom. Leguminous plants are said to have a special power of assimilating and absorbing the nitrogen of the air. Plant out cabbages. Weed wheat, beans, peas. Soil live stock in yards. Cut clover, meadow grass, santfoin for hay. Cart out manure, and plough it in as soon as spread: evaporation now takes place, so that its salts of ammonia are dissipated. Furze seeds, if neglected in April, may still be sown. Sow white mustard after tares, to be eaten down in August and September, before flowering; it comes in sooner than the turnips, which are otherwise a better crop: sow 7 lb. per acre broadcast. Watch sheep, the fly is on the wing, and dress them. Wash and shear sheep: have ointment ready for wounded places. Hoe carrots and potatoes. Weed flax. Tie your hopbines and prune them when needful. Hoe young lucerne. Carry chalk, marl, and clay. Clean out ponds if not very short of water, else leave them till the winter. If you graze your cows, keep them in by day, out by night. Burn clay. Plant holly hedges, protecting them by hurdles and dressing with chalk. Burn lime: mix dry lime and salt together; for your wheat two bushels of lime to one of salt, and protect the mixture from the weather. Look to your bees: they are about to swarm. Hire harvest-men. Inclose waste ground. On turnip ground keep harrows and roller working close behind the ploughs in dry weather. Sow hardy turnips on land which has borne vetches and rye. Beans are in bloom. Horse-hoe mangold wurzel, clear for the second time, and hand-hoe. Single carrots and parsnips to intervals of about 8 inches to a foot, and repeat the hoeings through the summer. Continue planting out cabbage in a rich highly-manured soil: planted now, or early in July, they will be useful food for winter and spring use: horse-hoe and hand-hoe deeply as long as there is room between the rows. Hand or horse-hoe buck-wheat towards the end of the month. Hoe chicory towards end of month also, when it will require to be singled out to 6 or 8 inch spaces; as pasture, it will be ready for stocking early in the month, and ready for cutting all the summer. Watch growth of grass-lands, and stock accordingly. If the season be genial the pastures frequently will grow with such rapidity as to lose a portion of their nutritive value. In that case crowd on stock; bullocks first, sheep

next, and then horses, at distinct times, and eat it clean down. Keep an extra field in hay, so that in case the pastures fail you may have it to turn your stock into. Pull up thistles in wet weather, or spud them. Spread daily the droppings of the animals. Mow early meadows.

July.—Peas will soon be ready to harvest: mow and cut with hook and crook into bundles: leave to dry, daily turning them till fit to carry. Winter-sown beans will be ripe by the end of July. Horse-hoe carrots and parsnips for the last time. Single any plants left double, by means of children, and pull up young plants which have appeared, for carrot seed sown in April will keep germinating through May and June. Horse-hoe mangold wurzel at intervals this month. Hand and horse-hoe turnips. Hoe rape as soon as it is high enough not to be covered by the operation, then set it out as turnips, only, instead of singling, leave two or three plants together: continue sowing it through the month. Pull flax before the bolls have ripened. Sow autumn turnips on the flax and rye stubbles (Chivas' of Chester, excellent kind). On grass-lands, thin stock on dry subsoils; cool soils will carry as many as last month. Fat beasts and sheep should be ready for the market. Do not stock aftermath till fairly grown. Manure hay-fields from which a crop has been carried; the practice of manuring land after every crop is an excellent one, which may be expected ultimately to carry the day. Keep ewes well this month, so as to blossom early next month. Remove boar from sows till beginning of November. Wean lambs. Get ready barns, waggons, tarpaulins. Repair and make hurdles. Buy wethers for winter fattening. Look to shape, size, quality of wool, and flesh.

August.—Horse-hoe turnips. On light rich soils scarify the earlier stubbles, especially of peas; harrow and sow broad-cast stone or Chivas' turnip: roll and leave to grow: if not bulbs there will be a green bite useful for lambs. Pull seeding mangold wurtzel and carrots, and give them to the pigs. Pastures decline. Begin to use aftermaths, putting on them the drafted ewes and fattening beasts. In case of the pasture failing from dry weather there should be ready a few acres of tares, coleseed, second clover crop, Italian ryegrasses. Calves get lean and stunted now if keep be short, and no subsequent care will repair the defect. Sow Italian ryegrass with trifolium incarnatum for spring keep. In south of England corn is ripe. Do not let it get too ripe or you will not be able to cut it fast enough, and must lose much seed, and if wet comes on it will sprout. The crop should be clean enough to cut and cart away at once. Corn, with green weed in it, will require to be out six or eight days. Millers prefer corn that has not been allowed to get too ripe: the skin is thinner, and the produce of fine flour greater. Thin sown wheat has a stouter straw and is more easily harvested. Prefer to stack your grain: you may cart it from the field sooner; it will be safer from vermin. Put ram to ewes early this month, for early fat lambs. Stock farmers sell off their lambs

and draft ewes. Sows should farrow. Subsoil pastures and sow renovating grass seeds. Sow rye and winter barley for spring keep. Collect fern and heath for winter litter.

September.—Thin pastures still further. Reserve good keep for the ewes when put to ram. Balance farm accounts, putting a fair average value, rather under than over, on your stock, crops, &c., and charging about 7 per cent. for wear and tear on money laid out in implements, &c. Sow grass seeds. Sow rye, winter vetches, tares: sow two pecks per acre of winter oats with the vetches. Obtain seed from a colder climate and a different soil; it will then have a chance to improve. Sow about one to two inches in depth. It is a safe plan to steep your seed, though many farmers despise it, either in a solution of blue vitriol and water, or salt and lime. Lime the clover fallow. Look well to live stock. Wean early foals. Dip your sheep, to kill lice, in a solution of arsenic and soft soap. Turn pigs into woods and stubbles. Plant potatoes towards middle of this month. Cleanse winter fallows, and lay them up in ridges for the frost to do its work. Pick hops. Keep the hoe still actively employed. By no means put sheep on young clover, as every bite destroys a root.

October.—Wheat sowing principal operation of the month. Lime and plough clover stubbles. Roll and press immediately afterwards. Plough bean stubbles. Some of the turnip land will be ready: the crop having been partially removed, partially fed off. Potatoes are being, or have been, harvested. The land should be somewhat moist when sown with wheat, but not so much so as to knead under the horses' feet. Tie up oxen for Christmas beef. Begin with white or autumn turnips. Put up hogs to fatten, and for porkers and pickling a succession of smaller pigs. Horses require dry food. Sow wheat, winter beans, tares for second crop. Plant and take up potatoes. Look to fences and water-courses. Finish dressing your meadows. Plough winter fallows. Mow and collect stubble to lay on the cattle yards. Feed fattening sheep on turnips, not forgetting salt: hay and oil-cake may be added with advantage. Keep sheep on wettish land, reserving the dry soils for the rainy season. Towards end of month dress and plough your land for winter beans. Gather apples and pears, and make wood stacks. Store mangold wurzel, carrots, and turnips, such as you do not intend to be eaten off on the land. Keep roots dry and well ventilated: capital store-room under a stack of straw, on pedestals, I have found by experience. Turnips lose much moisture in a night, therefore it is best perhaps to gather as you want them. Sow another succession of winter vetches, having sown some in September for keep next May and June. Sow rye on stubbles: best done however during September. Fell timber. Manure grass-lands during dry weather. New roads bind best now. Land springs show themselves to the drainer. Pick hops. Plant fruit trees.

November.—Put cattle into straw yards and stalls. Feed them well or they will fall off in spring. Thresh to supply straw. Manure grass-lands in dry weather. Destroy ant-hills. Admit cattle and horses only to the driest pastures. Give sheep shelter. Clear water furrows on arable land. Complete operations of last month. Fell all kinds of timber not adapted for barking. Cut willows for baskets. Let the hedger make hampers, crates, hurdles. Put boar to sows. Wean foals. Store swedes. Erect dry walls. Let hedging and ditching go on. Flood water-meadows. Drain especially heavy soils. Subsoil and dress land for plantations, and plant after ploughing deeply. Drain young plantations. Dig and secure carrots and parsnips. Thin sheep pastures to their accustomed winter stock, which ought rarely to exceed one sheep per acre. Put breeding ewes on the bullock pastures. Watch for a mild morning to turn the water on your catch-meadows: keen winds and frosty air being hurtful to the young growth.

December.—Finish ploughing and subsoiling before the new year. Plough lea for oats. Cart lime and marl and spread upon the fields. Cart stones for roads and draining: manure to fields: grain to market. Bring home the purchased feeding stuffs. This month and the last are the most convenient season of the year for draining. Keep ewes and grazing sheep on the pasture through this month. Top dress with composts. Litter yards well. Thresh for straw. Clear old fruit trees of moss and mistletoe: prune in mild weather. Dig and dung. Trench and dig plantations, but plant only in mild weather. The rest as November.

Estimate of Stock and Food required for 100 Acres.

In forming an estimate of the "stock of different descriptions" required per 100 acres, it is to be remembered that very much depends upon accidental circumstances, the climate, nature, and quality of the soil; the extent of artificial grasses grown, the condition or "heart" of the land, &c. Good treatment of ordinary soil will enable a farmer gradually to double the number of the animals previously fed upon the same ground. Through his famous water-meadows, Mr. Pusey was enabled to quadruple his sheep, while by improved cultivation he doubled the corncrops of the tenant, who previously occupied the farm. Twenty acres of his catch-meadows afforded keep for five months, for the wondrous multitude of 400 sheep; while on another meadow of 2 acres he fed to "thriving condition" no less than 73 lambs. So well did Mr. Pusey find these meadows answer, that at last he dispensed altogether with laying any part of his arable farm into clover or seeds. While on a farm of 104 acres, Mr. Littledale of Seacombe maintains no less than 83 milch cows of the large Yorkshire breed, and 15 farm-horses; and on a farm of Lord Leicester's of about 1200 arable acres, 200 pasture, Mr. Hudson keeps the annual average of 2500 sheep, 150 bullocks, and 36 working horses; there is land of which it takes 4 acres to

maintain a cow. While Mr. Dickenson obtains 6 tons of hay from one acre of his Italian rye-grass; and a small field of 3 acres of the same grass, on Mr. Stansfield's estate in the West Riding, yields the entire summer food of 6 work-horses and 5 bulls, besides supplying a fresh bite for the cows twice a day when they are brought in to be milked; on other farms it is hardly a satisfactory crop.

No general rule can therefore be given to the young farmer on this head; a fair average proportion may be stated for a farm where the plain pasture, without aid of artificial grasses, is looked to for summer keep, and for winter hay with roots, and this I estimate as follows for the Summer:—

	Sheep.	Horses.	Cows.
1 acre of very good land will maintain	..	..	1 to $1\frac{1}{2}$
Ditto ditto	5	..	1
Ditto ditto	12	..	..
Ditto ditto	..	2	..
1 acre of good average land will maintain	2 to 3	..	1
Ditto ditto	8	..	..
Ditto ditto			
1 acre of poor land will maintain	..	..	$\frac{1}{2}$
Ditto ditto	5	..	..
Ditto ditto			

During the Winter each of my cows upon an average consumes daily 16 lbs. hay and 40 lbs. roots. Upon their roots they have a sprinkling of bran, bean, barley, or oatmeal: sometimes in lieu thereof $\frac{1}{4}$ lb. daily of oilcake.

Upon this keep they average, now February 26, 6 to 7 lbs. of butter each per week, having calved in December, January, and February, although several are far more aged than it is advisable to keep them, being 11 to 12 years of age, one yielding 9 lbs. herself. They are besides in prime condition, being half ready for the butcher. They are turned out for some hours daily on a very bare pasture, and have water before them in their stalls.

My horses work hard, and are in excellent condition, upon an allowance for the 24 hours of $11\frac{1}{2}$ lbs. oats, 2 lbs. bran, chaff $\frac{2}{3}$ wheat straw to $\frac{1}{3}$ hay (28 lbs.). In addition they have 3 or 4 turnip-bulbs daily. The horses are of a powerful stamp, standing nearly 16 hands high; two being of the Suffolk breed.

For the winter a sheep requires about 1 cwt. hay, 1 ton roots, upon the field which it has grazed the summer through.

A calculation founded upon the above estimate of summer and winter keep required for a single animal, will enable the young farmer to combine his stock according to his fancy, some preferring sheep, some cows, and others pigs.

Pigs.—Of this latter class of animal, the number to be kept depends entirely upon the quantity of garden refuse, the extent of

dairy convenience, of obtaining grains, the amount of corn and beans allowed, &c. As a rule one breeding sow to 100 acres, to have two litters a year, will be found sufficient, combined with a due proportion of other stock.

Estimate of Amount of Men, Horses, Oxen, and Principal Implements required upon a Farm.

	Acres—Mixed, Arable, and Pasture, but mainly Arable.					
	100	150	200	300	500	800*
Carts	2	3	3	4	4	6
Waggons	1	2	3	3	4	6
Liquid-manure cart	1	1	1	1	1	1
Crusher..	1	1	1	1	1	2
Iron rollers	1	1	1	1	2	2
Horse-hoe	..	..	1	1	1	1
Ploughs..	2	3	3	4	6	9
Double-mould-board plough	1	1	1	1	2	2
Light grass-harrow, or chain harrow	1	1	1	1	1	2
Pairs of heavy harrows ..	1	2	2	2	3	3
Chaff cutters	1	1	1	1	1	2
Turnip cutters	1	1	2	2	3	5
Horses	4	6	6	8 or 9	8 or 9	10
Oxen	..	..	..	..	2 teams	4 teams
Reaping machine	1	1	1	1	1	2
Cultivator and skimmer ..	1	1	1	1	1	2
Turnip drill	1	1	1	1	1	2
Grass-sowing machine ..	1	1	1	1	1	1
Corn drill	..	..	1	1	1	1
Hay-tedding machine.. ..	1	1	1	1	1	1
Horse rake	1	1	1	1	1	2
Turnip scufflers	1	1	2	2	3	5
Winnowing machine	1	1	1	1	1	1
Oat crusher	1	1	1	1	1	1
Oilcake breaker	1	1	1	1	1	1
Threshing machine	..	..	..	1	1	1

* 600 arable, 200 pasture.

For a farm of 100 acres of mixed husbandry, there will be required a ploughman and lad to follow the two teams, the man to clean and feed the horses, when the lad can help in other work; a man to tend the pigs and cattle; a labourer-of-all-work to do hedging, &c., and to help generally: in all 4 hands. An amateur farmer who studies neatness regardless of expense would require another man.

For a farm of 300 acres, there are required, a shepherd, a cattleman who shall also attend the chaffcutter, two ploughmen and two lads for the teams; two men for general work: in all 8 hands.

For 500 acres there will be required a shepherd, two men to attend cattle and chaffcutter through the winter, and for whom abundant summer work may be found on the farm; three men and three lads for the teams; and three men for general work: in all 12 hands.

The foregoing number of hands is the usual complement; at times there will be occasion to employ some in addition for job-work.

The due number of hands for the intermediate farms of 150 and 200 acres, we take it for granted the young farmer can calculate from the above data.

On the above noticed farm of 800 acres there are employed four men and four lads in attendance on the bullock teams; four men and one boy for the horses; one head shepherd, with two men and a boy to assist him; one man to attend chaffcutter; one man for the nag-stable and household jobs; two men for hedging and ditching, so as to keep the fences in fair tenantable order; four general labourers: in all 19 hands. The swede-cleaning, &c., is done per acre by occasional hands: and there are extra men employed at present for the draining, levelling of quarries, grubbing of hedge-rows, straightening of fences, &c.; and no farm could be better managed than it is.

The force of hands and implements you will notice does not rise in exact proportion of the increased number of acres. Comparatively a small farm requires more hands and machinery than a large one. On a large farm steam and horse power do much that is done by manual labour on a smaller one. The above average of implements in general use is gathered from our own, and the practice of the best farmers, in this a fair undulating country. In a flat country waggons may be dispensed with, carts with shifting harvest bodies being substituted. Carts answer better in a flat country, being quicker, while 2 horses in carts some consider to do more than the same 2 in a waggon. In a hilly country you must have waggons, on account of the necessity of locking the wheels down the steeps. The above estimate may vary too with the number of homesteads in the occupation of the farmer.

XIII.—*On Paring and Burning.* By Dr. Augustus Voelcker.

Perhaps few agricultural operations, even long after they have been practised with marked success in a district, can be said to be so firmly established as to meet with universal approval. There will, on the contrary, always be men who, in the face of long and extended experience, will doubt the economy of certain agricultural operations, or deny their accordance with sound principles, or their consistency with modern improvements.

Paring and burning, a practice carried out with much benefit in various parts of England, and in none with better results than on the Cotswold hills, has shared this general fate of many other agricultural practices. Like deep drainage, subsoiling, autumn-ploughing, deep cultivation, the application of artificial manures, and other high-farming operations, paring and burning has been the subject of lengthened discussion in our agricultural

periodicals. On the one hand we possess the testimony of trustworthy and acknowledged good farmers, who all speak very favourably of this mode of raising produce; on the other hand, there are not wanting men of intelligence who advise agriculturists not to adopt paring and burning as a regular farm routine; and some men who go to the length of condemning this practice unconditionally, as being wasteful and inconsistent with scientific principles and good practice. We cannot feel surprised at such great diversity of opinion if we bear in mind how difficult it is with most men to discard preconceived theoretical views; how little, comparatively speaking, is known of the *rationale* of even common farm practices; how much more easy it is to give vent to speculations than to establish a single fact; and how few men are capable of explaining in intelligible language the more direct cause or causes of their success, and of the failure experienced by others. Again, it is an undeniable fact that fixed rules cannot be laid down in agriculture, of which it can be reasonably expected that they will lead invariably to the same results; for it is self-evident that the very same operation which in one locality perhaps has doubled the produce, may in another district remain unattended with any benefit, or, under unfavourable circumstances, may even do harm instead of good. We must, therefore, be prepared to meet with discussions on agricultural matters, and to expect, it may be, plans, proved by long personal experience, to be called in question, or even to be condemned or ridiculed.

In the absence of scientific principles—and agriculture will always more partake of the characters of a practice than of those of science—agricultural discussions, carried on in a candid and generous spirit, must be doing much good. They often ventilate the question under discussion in all directions, and tend by degrees to the establishment of principles useful to intelligent men. Uniformity of opinion leads to stagnation, and this, in the world of intellect, is as baneful as it is in the physical world, whatever the relations may be in which stagnation may be considered. Thus the discussions which appear from time to time in our agricultural periodicals on paring and burning are not so unprofitable as they may perhaps seem at first sight. For my own part, I feel indebted to them for several hints, which have much assisted me in the examination of the question: "Is paring and burning, as a regular farm practice, founded on correct principles or not?"

The object of the following pages is to record some experimental investigations made on this subject, and to adduce reasons, founded upon analytical evidence and well-established agricultural experience, in support of my conviction that paring

and burning on some kinds of soils is not only a profitable operation, but that it is, under certain circumstances, by far the most rational plan of cultivation which can be adopted, in our present state of knowledge, for raising upon some kinds of land the largest amount of produce with the least expenditure of money.

Objections against Paring and Burning.

Various objections have been raised against paring and burning, amongst which the following three are the principal :—

1. This practice has been condemned by some writers on the subject, because it destroys the organic matters in the soil, and thus causes a waste in a most important class of fertilising constituents.

2. Others less speculative, and therefore ready to acknowledge the benefits arising from paring and burning, notwithstanding object to it because they maintain that, although two or three good crops can be grown after paring and burning, this operation will leave the land afterwards in such an exhausted condition that the cost of bringing it again into a profitable state of cultivation will be found greater than the temporary benefit derived from paring and burning.

3. It is objected to on the ground of expense, and maintained that it is more profitable to lay out money in the purchase of guano, superphosphate, or other artificial manures, than to spend it in paring and burning.

Let us examine these three objections :—

1st. With regard to the first objection, it will be observed that it is taken for granted that organic matters are soil-constituents, which, under all circumstances, exercise a beneficial effect on the growth of plants, for which reason it is deemed most important by those who hold this view to preserve them as much as possible in the soil.

It cannot be denied that organic matters are desirable in *most* soils. The fact that well-cultivated and productive soils (like many rich wheat loams, and most garden soils) invariably contain much organic matter, has led many agriculturists to connect intimately the larger or smaller proportion of organic matter in different soils with their relative productiveness. Not many years ago it was customary with most agricultural writers to estimate the relative state of fertility of different soils by determining the amount of humus, *i. e.* decomposed organic matters in each. This, however, is clearly contrary to reason and well-ascertained facts ; for there are soils which, like peaty lands, or the soil of poor pastures, contain a very high percentage of organic matter, and yet are quite sterile. On the other hand,

there are soils which, like many very fertile clays, hardly contain any humus, and yet are highly productive. These inconsistencies have compelled the adherents of the humus theory to assume a number of such terms as dead, inert matter, sweet and sour humus—terms which, in the sense in which they are generally used even now are meaningless, and which for this reason might with much benefit be subjected to the process of burning.

The humus theory has retarded rather than promoted agricultural improvements. Happily it may be regarded at present as fully exploded. Had Liebig done nothing else for agriculture but to give the *coup de grace* to the humus theory, by means of his irresistible argumentative writings, the agricultural community would still be highly indebted to the great German chemist; for as long as this theory found favour with practical men, much to their disadvantage, the importance of the mineral constituents, so necessary for every description of agricultural produce, was altogether overlooked. It was reserved for Liebig to give general recognition to the fact, that the mineral matters which enter into the composition of plants are not merely accidental, but essential, constituents, without which plants cannot live; and to point out in a clear and convincing manner the necessity of the presence in the soil of those mineral matters which are found in the ashes of the plants we intend to cultivate. The influence of Baron Liebig's writings on this subject upon agricultural improvements can hardly be over-estimated. It is not saying too much that Liebig's writings have given a new impulse to agricultural pursuits, and created a new branch of industry, viz. the manufacture of artificial manures. Though unsuccessful in the first attempt to manufacture efficient artificial manures, Liebig has nevertheless opened the way to the manufacture and general application of artificial manures.

The failure of Liebig's mineral manures, to whatever it may have been due, however, does not prove the unsoundness of the principle so clearly announced in Liebig's writings, namely, the principle that plants cannot grow vigorously if the mineral constituents found in their ashes are deficient in the soil or in the manure applied to it. Liebig's position in enforcing this truth is unassailable ; nor has it indeed been assailed by any one who can lay claim to the title of a man of science. It is, in reality, not in principle but in practice that Liebig has failed. And this need not excite surprise ; for, however true a principle may be in the abstract, such a principle, if applied to a subject upon which it can have no bearing, is evidently misapplied, and likely to lead to errors in practice. Thus it is unquestionably necessary upon a purely sandy soil, containing very little besides

silica, to use a manure which includes all the mineral elements found in the ashes of the crop intended to be raised. In this case the abstract principle finds a strict application—hence a corresponding useful practical effect. But if a manure, composed entirely of the ash-constituents of plants, is applied to clay soils, and many other soils, containing an almost inexhaustible supply of those very minerals which are added to it in the shape of a mineral manure, it is plain that the same abstract truth can find no application. The result of such misapplications of a correct principle naturally must be what it has since proved to be in numerous instances—a complete failure. But, as just mentioned, the failure which has in many instances attended the application of purely mineral manures does not show that mineral substances are useless in relation to vegetable life, much less that organic matters after all are more important in relation to the growth of plants than mineral substances. These mineral matters are essential to the very existence of every kind of agricultural produce, and must, therefore, be present in the soil, or in the manure applied to it, or else they will not grow; organic food may be altogether wanting in the soil or the manure, for under favourable circumstances the plant can get it from the atmosphere. Thus in a certain sense mineral matters are the more important.

Whether it is advisable to apply *mineral* or *organic* food to the soil, in cultivating certain crops on land of a particular description, is another and, as far as practice is concerned, an equally important question. Here it may happen, and does happen, in the case of many soils, at least in England, that the artificial or direct *application* of minerals (not the minerals themselves) is of no use whatever. Speaking of the *application* of mineral matters in such a case, most purely mineral manures may justly be considered to be unimportant, or at any rate of doubtful efficacy—much less valuable than organic manures. But it cannot be said, in a general way, that mineral matters are less important than organic manuring elements, nor the reverse.

It is evident at the same time that it is impossible for practical men thoroughly to comprehend how far certain scientific principles are applicable in a particular case if these principles themselves are misunderstood; nor can it be expected that a place will be secured for science in the affections of the practical man if the teachers of science be unacquainted, or but very imperfectly informed, on practical matters. Scientific men too often fall into the grievous error of insisting upon the application of abstract principles under all circumstances.

Chemical principles, though they may not always find a direct application in agriculture, or though, when stated in the abstract, they may require to be greatly modified in practice, are, how-

ever, of primary utility to the occupier of land. The want of a clear perception of a scientific truth, and its bearing upon the farm routine, as followed in this or that locality, is a fertile source of endless disputes. In order fully to appreciate the objections of those who, I think, attach, generally speaking, too great an importance to the organic matters in the soil, it appears to me desirable to allude briefly to the functions of humus, *i. e.* organic matters in a state of progressing decomposition. I would, therefore, observe:—

1. Humus is an excellent absorber of moisture, and for this reason of special use in sandy and other naturally dry soils. In illustration of this property, the following partial analyses of two soils may find here an appropriate place. Both soils are from Buckinghamshire. Before proceeding with their analysis, I kept them in a heated room, in a powdered state, until they were perfectly airdry, neither gaining nor losing water when weighed from day to day. In this state they were analysed, and the following results obtained:—

	No. I.	No. II.
Moisture	4·70	22·35
Organic matter and water of combination ..	5·98	22·01
Oxides of iron and alumina	10·51	16·02
Carbonate of lime	1·32	·95
,, magnesia	·85	·43
Phosphoric and sulphuric acid	trace	trace
Alkalies, chlorine, and loss	·47	·56
Insoluble silicious matter (chiefly sand) ..	76·17	37·68
	100·00	100·00

No. I. was a soil in wheat, No. II. soil in permanent pasture.

The wheat soil, it will be seen, contained nearly 6 per cent. of organic matter, and retained, in a moderately-dry atmosphere, about 5 per cent. of moisture, which was only driven off at the temperature of boiling water. The pasture-land contained 22 per cent. of organic matter, and, under the same circumstances in which No. I. retained only 5 per cent. of moisture, was capable of retaining no less than 22 per cent.

2. Humus not only absorbs and retains moisture from the atmosphere, but also ammonia; and this it does in virtue of its porosity, no less than in virtue of the chemical affinity which the humic and ulmic acids found in humus possess for ammonia.

3. The organic remains in soils contain nitrogen, and, on gradual decomposition, give rise to the formation of ammonia, which at once is fixed by the humic acids generated at the same time during the decomposition of the organic matters of the soil.

4. Organic matters, in order to be decomposed, must be

brought into contact with atmospheric air, the oxygen of which changes them by degrees into brown and black humus, both of which include various organic combinations, characterised by great avidity for absorbing oxygen from the atmosphere, by which they are finally resolved into carbonic acid. Organic matters thus furnish a continual source of carbonic acid in the soil, and afford thereby organic food to the plant, which food appears to be highly beneficial in the earliest stages of vegetable life, before the green leaf is fully formed, and the more mature plant can avail itself of the carbonic acid of the atmosphere.

5. This process of slow oxidation, or eremacausis, to which all organic matters are subject in contact with the air, is attended with evolution of heat, which heat, of course, is beneficial to the growth of plants.

6. In virtue of the dark colour of humus, soils containing organic matters absorb more readily heat from the sun than others deficient in humus; and for this reason also organic matters appear to favour vegetable growth.

7. The vegetable remains of former crops, besides combustible elements, contain mineral matters: the latter, however, are so firmly united with the organic portion that they cannot be dissolved by water from the fresh organic matters. But in the measure in which the decomposition of the organic matter proceeds, the mineral matters are rendered soluble, and thus humus furnishes also mineral food to the growing plant.

For more than one reason, therefore, organic matters in the soil are capable of exercising a beneficial influence on plants. It may appear therefore highly desirable to preserve them by all means; and their destruction by fire would seem to be opposed to the first principles of good farming. There can be no doubt that, in many instances, paring and burning is inapplicable; but at the same time experience has shown that in other instances the destruction of the organic matter in soils is not attended with any evil consequences. There must exist therefore some cause or causes which afford an explanation of the benefits of a practice which appears contrary to what has been stated in regard to the functions of humus. Now it is quite true that humus absorbs moisture and ammonia from the atmosphere, but is it equally true that all soils stand in need of a good absorber of moisture and ammonia? Are there not some which seldom get even sufficiently dry, and for this reason are considered wet and cold soils? Are there not soils which contain constituents capable, like organic matter, of absorbing moisture and ammonia from the atmosphere and of retaining it? Again, are there not plants which find abundance of organic food in the atmosphere, and for this reason are not dependent for food on the organic matter in the soil? It is

evident that, if these questions can be answered in the affirmative, the most serious objections against paring and burning fall to the ground. If, moreover, it can be shown that by the destruction of useful matters we can realize a greater practical advantage than by any other known means, no cause will remain for lamenting their dissipation by fire. In this case their loss is equivalent to money well spent in other farming operations. The examination of many soils, upon which paring and burning is practised with manifest good results, has shown that they contain a large proportion of clay; and as clay possesses in a high degree the power of absorbing moisture and ammonia, it matters little if the organic matters in soils containing much clay are burnt away, for they still retain their power of absorbing atmospheric food for plants. In sandy soils, or light land deficient in clay, it would be decidedly wrong to pare and burn, but in heavy land, and all soils containing a fair proportion of clay, the organic matter may be destroyed without injuring the land, especially if it can be shown, as I hope to be able to show presently, that its destruction is attended with decided advantages.

2ndly. The second objection against paring and burning, namely, that it will produce a few good crops and then leave the land in such an exhausted condition, that the cost of bringing it again into a profitable state of cultivation will be greater than the temporary benefits derived from paring and burning, rests on the assumption that the soil furnishes all the food for the crops which are raised upon it, and that none of the matters taken from the soil are returned to it. This objection would indeed have some force if it were usual to pare and burn for corn crops, and to sell off the farm corn and straw. However, commonly land is pared and burned in preparation for turnips; the roots are then consumed on the land by sheep, and by this means the mineral matters taken up from the soil by the turnip crop are restored to it almost completely in the sheep's excrements. It is well known that turnips derive the bulk of their solid matter from atmospheric food. In passing through the body of sheep a considerable proportion of the organic part of turnips derived from the atmosphere is in the shape of excrements imparted to the soil. This added to the numerous fibres and decaying leaves enriches the land sufficiently in organic remains to meet the requirements of the subsequent corn-crop. No fear therefore need to be entertained that soils become impoverished by paring and burning, if this operation is performed as a preparation for root crops to be consumed on the land.

3rdly. The third objection against paring and burning, raised on the ground of expense, being a purely practical one, might be fairly left for settlement with those more directly interested in

this matter. I may observe, however, that I have been at considerable pains to ascertain the opinions of practical men on this subject, and have received reliable evidence that paring and burning, in the judgment of the best farmers on the Cotswold hills, is the most economical means of raising on land of certain descriptions a good crop of turnips; and that it has been followed for ages with the most successful results. Numerous personal inquiries lead me to confirm the opinion expressed by Mr. Caird, who says that the best farmers on the Wold burn the most.

Mr. Caird rests his opinion on the testimony of several practical men; amongst other things he mentions "a field which had been broken up from its natural state exactly fifty years ago; it was then pared and burned, and so started the first crop of turnips, which supported the other crops of the course. The same process had since been seven times repeated; no manure of any kind had ever been applied, except such as arose from the consumption of its own produce on the ground, and the crops in each succeeding rotation had shown no sign of decreasing. The soil, which lies on the lower oolite formation, is very thin, but as it is not more so than when first broken up, its depth must have been maintained by the ploughman, perhaps imperceptibly, bringing up some fresh subsoil after each burning."

It affords me peculiar pleasure to show the perfect agreement of this practice with scientific principles; and I hope likewise to be able to show that the money laid out in paring and burning is much more economically spent than by purchasing guano, superphosphate, or other manures for root-crops.

On the Changes produced on Paring and Burning.

In order to enable the reader fully to understand the advantages resulting from paring and burning, it now devolves upon me to explain briefly the changes which take place in the constituents of the soil submitted to this operation.

These changes are of a twofold character.

The first relates to the action of fire on the organic matters, the second to that of fire on the mineral substances of the soil. Let us consider each separately.

1. *Action of Fire upon the Organic Matter of the Soil.*

All cultivated soils contain organic matter, some in smaller, others in larger proportions, in the shape of decaying or decayed roots, leaves, &c. In badly drained and in naturally stiff soils these organic remains rapidly increase from year to year, whilst under ordinary cultivation such an accumulation of organic matter does not take place on sandy, porous, and well-drained, light soils.

The more clay a soil contains, the more retentive and the stiffer it is; the more impervious the subsoil upon which it rests, the less perfectly air can find access to the interior of the soil and the more rapidly these vegetable remains increase in it. Hence the large proportion of organic matter which is found in land resting on the impervious forest marble clay, a description of clay which I believe would not be unproductive if it were efficiently drained, and altered in its physical characters by other approved mechanical means. Hence also the large amount of vegetable remains in land laid down in permanent pasture, or in soils after one or two years' growth of clover or sainfoin.

In clover-lea or old sainfoin soils there is a great abundance of vegetable matter, arising from the clover roots and decayed leaves, as well as from the weeds, couch, thistles, &c., grown upon it. Generally vegetable matter in sufficient quantity can be raked together to burn a large quantity of soil, without the addition of any other combustible matter. On burning, the organic portion of these vegetable remains is destroyed for the greater part, and the mineral and saline matters contained in every kind of vegetable matter are left behind, mixed with clay and other mineral matters of the soil, more or less changed by the action of the fire.

The general character of the ashes left on burning vegetable matters, freed as much as possible from adhering earth, may be illustrated by two analyses, made some time ago in my laboratory.

I selected for examination two weeds, which infest very generally the calcareous clay soils and brashy land on the Cotswold hills, namely, the stemless thistle (Carduus acaulis) and couch. The first when gathered contained from 25 to 26 per cent. of dry substance and 74 to 75 per cent. of water, and left on burning 9·66 per cent. of ash.

The ash of this thistle submitted to a partial analysis furnished in 100 parts:—

Composition of the Ash of the Stemless Thistle (Carduus acaulis).

Potash and chloride of potassium	27·40
Chloride of sodium	·90
Lime	41·44
Magnesia	4·40
Oxide of iron and alumina	2·01
Phosphoric acid	5·36
Sulphuric acid	2·92
Soluble silica and sand	3·50
Carbonic acid, and loss	12·07
	100·00

Lime it will be seen is the principal constituent of this ash. This may account for the fact that this thistle delights to grow

on the calcareous formation of Gloucestershire. In addition to lime, this ash contains a very large proportion of salts of potash, and besides sulphuric acid, soluble silica, and several other less important mineral fertilizing constituents, an amount of phosphoric acid which is by no means inconsiderable. This acid is evidently united chiefly with lime as phosphate of lime.

In preparing the ash of couch, it was found extremely difficult to separate adhering clay; notwithstanding all care the removal of adhering fine soil from the couch was incomplete, as will be seen by a glance at the subjoined analyses.

Couch on burning furnished an ash, coloured slightly red by oxide of iron, derived no doubt chiefly from adhering clay.

100 parts of this couch ash were found to contain by my friend and pupil Mr. Kensington, now assistant to Professor Anderson of Glasgow:—

Composition of the Ash of Couch.

Potash	10·02
Soda	5·69
Chloride of sodium	3·34
Lime	5·58
Magnesia	·04
Oxides of iron and alumina	12·40
Phosphoric acid	9·38
Sulphuric acid	5·33
Soluble silica	24·92
Insoluble silicious matter (chiefly sand) ..	17·50
Carbonic acid, and loss	5·80
	100·00

These constituents probably are united in this couch ash as follows:—

Carbonate of potash	14·10
Potash in a state of silicate	·27
Soda in a state of silicate	5·69
Chloride of sodium	3·34
Oxides of iron and alumina	12·40
united with phosphoric acid	9·38
equal to bone-earth	(20·32)
Sulphate of lime	9·06
Carbonate of lime	3·30
Magnesia in a state of silicate	·04
Soluble silica	24·92
Insoluble silicious matter (sand)	17·50
	100·00

The ash of couch it will be observed differs in several respects from that of the stemless thistle. The latter contained but little silica, whilst soluble silica is the chief constituent of couch. Again, the proportions of lime and potash in the thistle are much

larger than in couch, a fact which is interesting on account of both weeds having been collected from soils of a similar character. This is quite consistent with our present information on the particular wants of different families of plants. Thistles are evidently lime and potash plants, and couch appears to require much soluble silica for its growth, a fact which perhaps will explain its occurrence in sandy as well as in calcareous and clay soils. The two last-mentioned soils often, it is true, do not contain any silica in the shape of sand, capable of being mechanically separated from the other soils' constituents, but most clay soils are rich in alkaline silicates, from which plants unquestionably can take up soluble silica much more readily than from sand.

The large proportion of phosphoric acid in couch ash likewise deserves to be specially noticed. United with lime we have no less than 20 per cent. of bone-earth in couch ash, a circumstance which throws some light on the experience of many Gloucestershire farmers, with whom I have conversed on this subject, and by whom I am told that the fouler the land is, the better will be the crop of turnips, grown without any manure upon land simply pared and burned. I remember having walked once over a very foul piece of land full of couch, and was not a little amused by the remark of my agricultural friend who accompanied me: "What fine healthy couch, Sir, and will give me next year, I don't doubt, a splendid crop of roots, although I do not mean to put a single load of manure on this land." Considering the large amount of couch which is sometimes collected from fields and burned along with other vegetable remains, containing phosphoric acid, a very considerable dressing of bone-material must be given to the turnip crop in couch ashes. Indeed I have ascertained that a much larger proportion of bone-earth is brought within reach of the turnip plant in the red ashes obtained on paring and burning than is contained in a heavy dressing of bone-dust. I shall advert again to this point further on, and only observe in this place that phosphate of lime is the most valuable constituent of couch ashes, and that next to it, potash and sulphate of lime exercise beneficial effects upon the growth of root-crops.

The ashes left on burning other weeds and other vegetable matters found in soils, no doubt will present similar differences to those just pointed out in the analyses of the ash of couch and the stemless thistle. However great the differences in the proportions of phosphate of lime, potash, and other fertilizing constituents may be in the various kinds of vegetable remains which are reduced into ashes in paring and burning, every description of vegetable matter produces ashes containing valuable mineral manuring elements. These mineral constituents, before paring

and burning, are disseminated throughout a large mass of soil, and therefore of comparatively little value to crops which, like turnips, remain on the land but four or five months, and which are not provided with the food-searching apparatus which is presented to us in the long fibrous roots of wheat, clover, and various other plants. During the winter, these crops, prevented by the cold from making much progress in an upward direction, extend their roots downward, thereby establishing by degrees an apparatus which is ready to supply the growing plant with abundance of mineral food as soon as the warmer season of the year pushes on the young and fairly established plant. This, no doubt, is the reason why the direct supply of mineral substances in most soils produces hardly any effect upon wheat: quite the reverse takes place when root-crops are manured with minerals. It may be shown that a soil contains possibly 1000 times as much phosphate of lime as is contained in the ashes of a heavy crop of roots, for which reason a good dressing with superphosphate or bone-dust in the eye of the speculative chemist may appear wasteful and contrary to every chemical principle; and yet it can be proved that such a dressing must do good to turnips. What does the young turnip gain, if there is plenty of phosphate of lime in the soil and the plant cannot reach it; or what benefit is a superabundance of phosphate of lime spread all over the field, when the turnip crop is stopped in its growth by the cold weather in autumn, before the crop has had time to collect the disseminated phosphates in a sufficient quantity to enable it to form large bulbs? The shorter the period of vegetation the greater the necessity of a superabundant supply of mineral matters in that portion of the soil which is within reach of the plant. Hence the direct supply of bone-dust or superphosphate to a portion of the soil produces such marvellous effects; thoroughly incorporated with the whole mass of soil, it would do much less, if any good. Hence also the great value of the ashes produced on paring and burning. The roots of the plants which furnish these ashes penetrate the soil to a great depth, and having ransacked the soil, so to speak, in every direction, and sifted out of it the phosphate of lime, potash, &c., which constitute but a very small proportion of the whole mass of soil and subsoil, leave these and other important mineral fertilizers, on burning, in a small compass. Incorporated with a portion of the surface soil, they superabundantly enrich it with those fertilizing constituents, which experience has shown to be especially valuable for root-crops.

If the roots, &c., of former crops exercise such a beneficial effect, it may be said, why not let them become gradually decomposed? By doing this, would the farmer not realize all the advantages of a concentration of mineral food in the surface soil,

and at the same time be benefited by the organic portion of the vegetable remains of former crops? In reply to this question, it may be stated that couch and the roots of clover, &c., do not readily lose their vitality nor decompose with sufficient rapidity to admit of this plan being carried out in the cultivation of root-crops, for which paring and burning is specially adapted. In fresh roots and other vegetable remains, the saline inorganic constituents, found in their ashes, are so firmly united with organic constituents, that it is impossible to dissolve by means of water any appreciable quantity even of such soluble combinations as alkaline salts. By the decay of vegetable matters, their mineral constituents are gradually rendered soluble, and by the rapid destruction by fire their mineral matters are at once made soluble and rendered available to the immediate use of plants. These saline mineral constituents, in such a soluble state, act as powerful manures; and hence it is that paring and burning produces an immediate effect upon plants which, like all quick-growing plants, require, so to say, ready-made or soluble mineral food.

The excess of undecomposed organic matters in soils, moreover, is decidedly injurious to vegetation. Peaty soils furnish familiar examples of this. Soils upon which paring and burning is practised with the most benefit contain often much and always a fair proportion of clay; they are impervious and compact in texture, and for this reason do not readily admit air. The roots, stems, and other vegetable matters remain, therefore, buried in the ground for years without undergoing decomposition, or that preparation which we have just seen is so necessary to their yielding soluble fertilizing substances to a quick-growing crop. Thus the destruction by fire of the organic remains in heavy soils, far from doing any harm, is the most available and economical means of preventing their undue accumulation. The fire, I would observe, in concluding this part of the subject, destroys insects, their eggs and larvæ, as well as the seeds of weeds, bits of underground stems, which, like the knots of couch, are so apt to vegetate again, and which, therefore, cannot be got rid of so effectually as by burning. In short, nothing cleans land so thoroughly as paring and burning.

2. *Action of Heat on the Inorganic or Mineral Matters of the Soil.*

The heat generated during the combustion of the organic remains affects the mineral or soil constituents, properly so called, at least in part, producing in them changes which are partly of a mechanical, partly of a chemical kind.

In a former contribution to this Journal I have described, in

detail, the nature of the physical and chemical changes which take place in clay soils on burning. In order to save the general reader the trouble of reference, I will just briefly state some of the results which I obtained in a number of analytical experiments, and beg to refer those specially interested in clay-burning to Vol. XII. page 496, of this Journal, where a paper of mine will be found, entitled, 'On the Causes of the Efficacy of Burnt Clay.'

The mechanical effects of heat on clay are simple and easy to be understood. Heavy stiff clay soils are impervious to water, very tenacious and unctuous, and for these reasons often cold and expensive to work. Burning alters, at least to some extent, these undesirable qualities, and tends to render naturally stiff soils more porous and friable. But although the mechanical effects produced on clay upon burning are highly important, they do not sufficiently explain the full benefits which are obtained on the application of burnt clay or soil to the land. By a series of experiments I showed that in burning clay soils effects similar to those of fallowing are produced; and that many of the constituents of clay, more especially potash, are rendered more soluble by burning. It is to the potash liberated from clays on burning that I am inclined to ascribe the chief benefits resulting from the application of burnt soil as a manure. I further showed that those clay-soils, which contain originally a large proportion of undecomposed silicates of potash and soda, are best suited for burning, whereas soils and clays, resembling in composition pure pipe or porcelain clays, and all soils which contain mere traces of undecomposed alkaline silicates, are unfit for burning. Finally, I showed that the inefficacy of overburnt clay is due partly to the mechanical changes which clay undergoes in overburning, whereby it is rendered hard like stone, and, in consequence of its diminished porosity, becomes less efficient as an absorber of ammonia; partly to the chemical changes, whereby the constituents of clay soils are rendered less soluble than they are even in their natural state. Subsequent analyses of clays in their natural condition, and after burning, have fully confirmed the above-mentioned general results. Amongst others, I may instance a clay which has been sent to me for examination by Charles Lawrence, Esq., accompanied by the following note, which I have no doubt will be read with some degree of interest:—

"Dear Sir,—I now send you a specimen of clay, which underlies a blackish loam of variable thickness, from twelve to eighteen inches and more in depth; and, in reference to an article of yours which I read some time ago, I am desirous of ascertaining, first, whether it is of a description which would pay for burning and spreading over the surface, and, secondly, whether it contains constituents which would render it eligible as a manure to spread over and get it incorporated with light land which gets into a dust in the spring. The field from which this clay comes lies against the railway, and is quite of a different

character to any other on my farm. It was a very worthless pasture when it came into my hands, producing only coarse, wiry grasses and weeds. I had it drained, then pared and burnt in the winter of 1847, since which it has produced me a crop of oats, a crop of beans, and three crops of wheat, without manure. The oats and beans were more remarkable for an enormous bulk of straw than grain; but the wheat in each case produced, with abundant straw, forty bushels of grain per acre, though two of the wheat crops were in successive years.

I am, my dear Sir, yours very truly,

Dr. Voelcker. CHARLES LAWRENCE."

This clay, submitted to mechanical analysis, gave the following results:—

Hygroscopic (accidental) water	2·37
Water of combination	5·38
Carbonate of lime	31·38
Fine sand	2·25
Clay	58·62
	100·00

It will be seen that this is a calcareous clay, which, like most clay-soils in the neighbourhood of Cirencester, contains but a very trifling proportion of fine sand.

The detailed analysis of the same clay, being well calculated to illustrate the states of combination in which the constituents of this and similar clays occur, may find here a fitting place:—

Composition of Clay from Chesterton Farm, sent by Charles Lawrence, Esq.

	Hygroscopic water	2·37
	Water of combination and a little organic matter ..	5·38
	Carbonate of lime	31·38
Soluble in dilute acid.	Carbonate of magnesia	2·04
	Oxides of iron and alumina	11·90
	Potash	·35
	Soda	·18
Insoluble in acid.	Alumina	7·43
	Magnesia in a state of silicate	1·52
	Potash in a state of silicate	1·29
	Silica	36·16
		100·00

By far the larger proportion of the potash, it will be observed, exists in this clay in an insoluble condition as silicate of potash, and as it contains much lime, which, as shown in my previous communication, reacts upon the silicate of potash, when clays are burnt at a proper temperature, causing the liberation of potash and the production of silicate of lime, there is no doubt that this clay is well adapted for burning, and in a burnt state likely to do much good to light land. In its natural condition it yielded only ·35 per cent. of potash to very dilute acids, and after burning,

rather more than double that quantity, or, in exact numbers, ·77 per cent.

That burning has the effect of rendering other constituents besides potash more soluble in dilute acids, is clearly shown in the subjoined analytical results obtained with this clay in its natural state, and when burnt, at various temperatures. In two separate determinations it gave in its natural state:—

	1st Experiment.	2nd Experiment.
Insoluble matters in dilute acids ..	56·30	55·17
Soluble ,, ,, ..	43·70	44·83
containing potash	(·35)	
	100·00	100·00

Heated very moderately it yielded:—

Insoluble matters in dilute acid ..	50·90	52·31
Soluble ,, ,, ..	49·10	47·69
containing potash	(·77)	
	100·00	100·00

Exposed to a somewhat stronger, but still by no means a very high temperature, it produced:—

Insoluble matters in dilute acids	46·20
Soluble matters	53·80
	100·00

These experiments thus show plainly that the solubility of clay in dilute acids is regulated by the degree of heat to which it is exposed. A certain degree of heat is necessary to induce a proper chemical reaction; but, as demonstrated by former experiments, an excessive heat should be carefully avoided, inasmuch as it has the effect of rendering burnt clay again less soluble. It is, no doubt, for this reason, and not on account of a little charcoal which is obtained, that practical men recommend stifle burning, for this prevents the heat of the heaps of burning clay getting too intense, and consequently stifle-burnt clay is always very porous, crumbles readily to powder, and is more easily soluble than clay burnt at too high a temperature. In accounting for the advantages of paring and burning, the changes in the inorganic matters of the soil must not be overlooked; for soils which are regularly pared and burned often contain much organic matter, and afford therein fuel for burning a considerable quantity of the soil itself.

On the Soils well adapted for Paring and Burning.

As stated already, it is not all soils that can be pared and burned with advantage. It becomes, therefore, a matter of some

importance to decide beforehand which soils may be pared and burned with advantage and which not. It appeared to me, therefore, desirable to examine the characters of some soils, upon which paring and burning is practised with marked beneficial results. To this end I procured some soil from one of the fields on the farm attached to the Royal Agricultural College, and from another in the neighbourhood of Cirencester. The field from which the former was taken was at the time in sainfoin, which had partially failed: this field was afterwards pared and burned, and I had thus an opportunity of analyzing the red ashes procured by the combustion of the vegetable matter in the soil and the action of the heat upon the mineral constituents of the same soil. These two soils differed much in their physical characters, but agreed so far as to be much improved by paring and burning. The soil from the Royal Agricultural College farm, on analysis, furnished the following results:—

Composition of a Soil from the Farm of the Royal Agricultural College.

Moisture	5·981
Organic matter	13·217
Oxides of iron and alumina	12·954
Carbonate of lime	7·578
Sulphate of lime	·431
Carbonate of magnesia	1·414
Phosphoric acid	trace
Potash	·520
Soda	·122
Insoluble silicious matter (chiefly clay) ..	57·092
Loss	·691
	100·000

The depth of this soil is not more than 5 inches in the deepest places, and in some parts of the field it reaches barely 3½ inches. It is full of stones (limestones), and affords a good example of the thin brashy soils which abound on the Cotswold hills. With the hill farmers, land of that description passes as light land; but it may be observed that it is light merely on account of the prevalence of fragments of limestones, varying from the size of the palm of a hand to that of a bean. The pulverized portion of the soil, separated from the stones, is destitute almost altogether of sand, and constitutes a very stiff impervious clay. Although termed light land, it is well adapted for paring and burning, for in the pulverized portion clay greatly preponderates, and, on account of its impervious character, organic matters rapidly accumulate in it, and furnish combustible elements in a fair proportion.

I have also ascertained its mechanical state of subdivision, by passing a large quantity of air-dry soil through a series of cul-

lenders, and in this way obtained from 37,205 grs., or about $5\frac{1}{2}$ lbs.:—

	Grains.
Large stones	3,318
Smaller stones left on a $\frac{1}{2}$-inch sieve	1,438
Small stones and indurated clay left on a $\frac{1}{4}$-inch sieve	10,691
Soil left on a $\frac{1}{8}$-inch sieve	9,135
,, $\frac{1}{16}$-inch ,, ...	9,954
,, $\frac{1}{32}$-inch ,, ...	1,820
Very fine soil, which passed through a $\frac{1}{32}$-inch sieve	849
	37,205

The five last portions were well mixed together, finely powdered, and the whole passed through the finest sieve; a portion of this was then employed for analysis.

The second soil, on analysis, gave the following results:—

Composition of Soil from the neighbourhood of Cirencester.
(Well adapted for burning.)

Moisture	·93
Organic matter	10·67
Oxides of iron and alumina	13·40
Carbonate of lime, with a little sulphate of lime ..	23·90
Carbonate of magnesia	1·10
Phosphoric acid	trace
Potash	·38
Soda	·13
Insoluble silicious matter (chiefly clay)	49·66
	100·17

This is a much deeper soil than the preceding one; it is tolerably free from stones, and extremely stiff and difficult to work. Like many other soils resting on forest marble clay, it is rather wet, though it had been drained. It affords an example of land called in the district heavy land.

Both the light and the heavy soil contain more than an average proportion of organic matters. Their destruction by fire does in nowise injure the land in either case, for both contain a large amount of clay, which, it is well known, possesses in a high degree the property of absorbing ammonia and moisture from the atmosphere; and as burning tends to accumulate in the surface-soil a large proportion of saline mineral matters, and otherwise improves the mechanical condition of the land, we need not lament the dissipation of organic matters by heat.

The first soil presents us with an instance, showing how desirable it is not to be content, in descriptions of agricultural operations, with general terms, such as light land; for such terms are apt to mislead others not acquainted with the true

character of a soil on which a practice like that of paring and burning answers very well.

Were a farmer to burn light sandy soils, he would, as a rule, do decidedly wrong, for sandy soils are naturally open and porous; they readily admit atmospheric air, and consequently the decomposition of organic matters in the soil proceeds rapidly enough. It would thus be not only a needless expenditure to pay for the cost of paring and burning, but the destruction of vegetable remains in most sandy soils would also be followed with evil consequences; for it is evident that the destruction of constituents which possess the power of absorbing moisture and ammonia from the atmosphere must do harm in soils which do not contain, like clay soils, mineral matters which are capable of fulfilling this useful function.

On Red or (so-called) Vegetable Ashes.

(*Vegetable Ashes and Burnt Soil.*)

The favourable opportunity I had of collecting the red ashes produced on paring and burning both soils, the composition of which has just been stated, induced me to examine the ashes of each separately. In one instance, moreover, I ascertained the total amount of the red ashes per acre, and, having made a careful analysis of a well-prepared average sample, I am enabled to state in exact numbers how much phosphate of lime was contained in these ashes.

Composition of Red Ashes from a Field on the Farm attached to the Royal Agricultural College.

The physical characters of the soil of this field, as well as its chemical composition, have been described already; I need not, therefore, repeat the analysis expressing its chemical composition. The season, on the whole, was favourable for burning, and the soil, which, it will be remembered, contained, in an air-dry condition, about 13 per cent. of organic matter, was sufficiently dry to allow of its being burned in a fair average quantity. The probable produce in red ashes, as estimated by inspection of the number and size of heaps of ashes on the field, did not appear very great; this soil, it will be remembered, had no depth, and therefore could not give, on paring and burning, a very large quantity of ashes. In many instances I have seen, on the hill-lands in our neighbourhood, double the quantity of ashes per acre. The soil in the field was burned in small heaps, varying somewhat in size. Each little heap produced from 2½ to 4 bushels—or, on an average, about 3 bushels of red ashes. On an acre of land I counted 146 such heaps. Weighed in their

natural condition, I found that 1 acre had furnished 14 tons 17 cwt. 2 qrs. 11 lb., or, in round numbers, 15 tons of red ashes.

A large sample, amounting to several pounds, taken at the same time when the ashes were weighed, was finely powdered, well mixed together, and in a portion of it the amount of water determined at once:—

	1st Exp.	2nd Exp.	Average.
Amount of water in red ashes when weighed ..	22·36	22·04	22·20

According to these determinations, the rough produce per acre, amounting to nearly 15 tons of ashes, will give 11 tons 11 cwt. 2 qrs. 4 lbs., or nearly 12 tons of perfectly dry ashes (dried at 212°).

As ashes are sometimes mixed with superphosphate and drilled in for turnips, and the ashes usually measured out, I may observe that I find the weight of a bushel of red ashes, on an average, to amount to 72½ lbs. This weight refers to ashes not sifted, but just as they are when taken from the heap. Finely sifted ashes of that kind, I imagine, would weigh rather more.

A well-prepared fair average sample was next used for analysis, and, in the state in which it was analysed, found to contain 1·18 per cent. of accidental moisture. This sample had a dull or dirty red colour, due to oxide of iron and some charcoal not completely burned off. Much, however, of what is mentioned in the following analysis under Organic Matter and Water of Combination, I am inclined to think is water of combination, and arises from the admixture of unburnt soil.

The following table exhibits the composition of these ashes:—

Composition of Red, so-called Vegetable, Ashes from a Field on College Farm, Cirencester.

Moisture	1·18
Organic matter and water of combination ..	3·32
Oxides of iron and alumina	18·42
Carbonate of lime	8·83
Sulphate of lime	1·15
Phosphoric acid	·71
(equal to bone-earth)	(1·56)
Potash	1·08
Chloride of sodium	1·03
Magnesia	1·76
Insoluble silicious matter	62·52
	100·00

These analytical results suggest one or two observations:—

1. It will be observed that the proportion of phosphoric acid in these ashes is considerable in comparison with the amount of this acid found in soils. Even in very fertile land it rarely amounts to two-tenths or three-tenths of one per cent.

2. The ashes contain, as will be seen, a large proportion of potash in a soluble condition, as well as of chloride of sodium; and as alkalies are very beneficial to green crops, the presence of alkalies, especially that of potash, no doubt accounts in part for the benefits resulting from the application of red vegetable ashes to root-crops.

2. The insoluble silicious matter consists chiefly of burnt clay, and contains a good deal of potash in a state in which it is not at once soluble in water. But as burnt clay is more readily penetrated by atmospheric air, there can be no doubt that the insoluble potash contained in it will be rendered soluble and made available for the use of plants much more readily than it is from unburnt clay.

I have just stated that the total amount of perfectly dry ashes per acre was ascertained to be 11 tons 11 cwt. 2 qrs. 11 lbs. 100 parts of these ashes contained ·71 of phosphoric acid.

This percentage, calculated for the total produce in ashes, gives 184 lbs. of phosphoric acid; 184 lbs. of phosphoric acid, united with lime, give 398 lbs. of tribasic phosphate of lime or bone-earth per acre.

Commercial bone-dust, I find, contains, on an average, 46 per cent. of bone-earth. 398 lbs. of bone-earth, accordingly, are equivalent to the phosphate of lime contained in 7 cwt. 2 qrs. 25 lbs. of commercial bone-dust.

The weight of a bushel of bone-dust varies from 40 to 44 lbs. Taking 43 lbs. as the average weight per bushel, 7 cwt. 2 qrs. 26 lbs. of bone-dust will give almost exactly 20 bushels.

Thus the ashes from this field contained a quantity of phosphoric acid which is equal to that contained in 20 bushels of bone-dust.

This is an important fact, and affords the explanation why vegetable ashes are so beneficial to turnips, and why better crops of roots are obtained on the thin brashy soils of the Cotswold hills, by paring and burning, than with the use of any amount of farmyard manure or any description and quantity of artificial manure. Many Cotswold hill farmers are not a little proud of growing good roots on poor thin soils without manure. I once heard a farmer in our neighbourhood quite exult in the idea that he never used a single bushel of bone-dust for his turnips, and had not the least confidence in phosphates, or would ever think of using superphosphate, or any other new-fangled manure, for his roots. But are red ashes no manure? In point of fact, the land, in the case before us, received a heavier dressing of essentially valuable fertilizing constituents in these ashes than it would be likely to receive in any other description of manure,

for I take it for granted that no farmer would think of laying out on such poor thin soils as the one from which the ashes were obtained something like 2*l*. 10*s*. per acre for bone-dust alone.

My agricultural friend, no doubt, was perfectly right in his practice, but not quite in his theoretical speculations respecting the utility of phosphates for root-crops. Perhaps he would have had a more favourable opinion of phosphates, if he had been told that the red vegetable ashes which he was in the habit of using in all probability contained more phosphates than a very heavy dressing of the best superphosphate, or perhaps 20 tons of good farmyard manure.

Moreover, there are good reasons for the fact that, on land which is well adapted to be regularly pared and burned, farmyard manure, guano, superphosphates, or other artificial manures, often do no good to turnips, or, at any rate, do not improve root-crops in the same degree as vegetable ashes. I shall revert to this subject again, after having given an account of the ashes from the second and stiffer field in our neighbourhood.

Composition of Red, or so-called Vegetable, Ashes from a Soil in the neighbourhood of Cirencester.

The red ashes from the College farm may serve to give a fair idea of the composition of the ashes which will be obtained on paring and burning, when the season is dry, and there is sufficient vegetable matter in the soil to keep the fire alive for six or eight days in small but well-covered heaps. Such ashes, of course, contain a large proportion of burnt clay. On the other hand, the subjoined analysis may serve to represent the composition of the vegetable ashes which will be produced in a wet or showery season on stiff soils of a wet description. There is a good deal of land of that character in the neighbourhood of Cirencester. Except in a very dry season it is impossible to get the clay sufficiently dry for burning. It often happens, therefore, that such land cannot be properly burned, that is to say, little of the soil itself can be burned. The ashes produced under these circumstances are, of course, much less in quantity, but at the same time a great deal more valuable, than the preceding ones.

This will appear clearly from the following table, in which is stated the composition of the ashes obtained on burning (principally) the vegetable matter of a soil from a field in the neighbourhood of Cirencester.

The composition of the soil before burning has been given above.

Composition of Vegetable Ashes from a Field in the neighbourhood of Cirencester.

Moisture and organic matter	9·12
Oxides of iron and alumina	14·56
Carbonate of lime	17·17
Sulphate of lime	1·73
Magnesia	·40
Chloride of sodium	·08
Chloride of potassium	·32
Potash	1·44
Phosphoric acid	1·84
equal to bone-earth	(3·98)
Soluble silica (soluble in potash)	8·70
Insoluble silicious matter	44·64
	100·00

A comparison of these analytical results with the analysis of the preceding ashes shows, amongst other things:—

1. That the former ashes contain much less phosphoric acid and less potash. And as the value of ashes as manure depends principally on these two constituents, a bushel of the last-mentioned ashes may be worth 2 or 2½ bushels of the first.

2. There is much less burnt clay in the second ashes, which accounts for the very much larger proportion of phosphoric acid and potash.

3. Both kinds contain a good deal of gypsum, and (especially the latter) much carbonate of lime. The large proportion of lime in these ashes is, no doubt, in great measure due to the calcareous character of the soils in our neighbourhood.

As just mentioned, in the latter ashes there was not so much burnt soil as in the former.

They may indeed be called, with propriety, vegetable ashes with some burnt soil, and the former, with equal reason, burnt clay with some vegetable ashes.

On the Relative Advantage of Farmyard-Manure, Artificials, and Vegetable Ashes produced by Paring and Burning.

It remains for me now to offer some remarks on the economy of paring and burning in comparison with the direct supply of farmyard-manure or artificial fertilizers, and also to state the reasons why I believe that on certain soils paring and burning is almost the only means of getting a good crop of turnips; and lastly, to show how it is that on such soils the best manures often do no good whatever, or even do harm.

In the first place I would observe that an average quantity of red vegetable ashes produced from one acre of ground contains a

larger amount of those fertilising constituents, which are especially useful to root-crops, than a heavy dressing of farmyard-manure, guano, superphosphate, or other artificial manures; and as the expense of procuring the ashes is certainly much less than that of even a moderate manuring, paring and burning must be considered decidedly an economical agricultural operation. Thus it has been shown that the bone materials contained in the ashes of an acre of land are equivalent to about 20 bushels of bone-dust, worth at the present time about 2*l.* 10*s.* Assuming the rest of the fertilising matters in the ashes to be worth only 10*s.*, which is a very low estimate, their total value in fertilising matters will be at least 3*l.* per acre. In this estimate no account is taken of the mechanical improvement of the land, of the uniform distribution of the manuring agents, and the advantages of paring and burning as a most efficient cleaning operation.

In the next place, I would remind the reader that most of the soils upon which paring and burning is practised with marked benefit are so impervious that, for want of necessary atmospheric air, the organic remains of former crops largely accumulate in the soil. This inert vegetable matter appears to be injurious to vegetation, or implies, at any rate, an unfavourable condition of the land, which has first to be amended before anything else can be done with it with effect. In our present state of knowledge no available means afford so efficient and cheap a remedy against this evil. There are no doubt soils which can be brought round by other means, but I question whether these means would be available on the thin, poor, brashy soils on the Cotswold Hills.

Lastly, it may be stated that artificial manures, such as guano and superphosphate, and even farmyard-manure, produce hardly any effect upon turnips when applied to land which is in a raw unprepared state. In proof of this assertion I may mention that two years ago I tried small and large doses of good superphosphate upon land which evidently was not properly pulverized, and did not get a single cwt. the acre more turnips from the manured plots than from those which were left unmanured. A more efficient operation can hardly be conceived than paring and burning for increasing the porosity of a soil and thoroughly pulverizing a large proportion of it. As a mechanical improvement it is therefore invaluable.

Soils well adapted for burning, we here see, contain invariably a large proportion of clay, from which, on burning, potash is liberated. And as the effect of potash appears to be similar to that of ammonia, viz. to favour the development of leaves, it is not necessary to apply ammoniacal manuring constituents to soils that have been pared and burned. Indeed, I am inclined

to think that under these circumstances ammoniacal manures do more harm than good. At any rate, direct experiments, repeated during three seasons, have shown me that on our farm ammoniacal salts either produce no effect upon the produce of roots or (if anything) diminish it. Many of the soils in this neighbourhood are extremely thin; and when it is considered that the ashes produced from them contain a large supply of readily available food, it will be easily conceived that the further application of much farmyard-manure is likely to induce an over-luxuriance in the turnips, which manifests itself in the development of large tops to the injury of the bulbs. Having observed this injurious effect of rich ammoniacal manures, I would suggest not to use any farmyard-manure, or guano, or, indeed, any other manure, in all cases in which a good quantity of ashes has been produced upon a naturally poor and thin soil.

The foregoing account of an inquiry undertaken with a special reference to the cultivation of turnips on certain thin soils, I trust embraces sufficient scientific and practical evidence to warrant the following conclusions:—

Conclusions.

1. The destruction of organic matter in soils adapted for paring and burning is not attended with evil consequences, because such soils contain a large proportion of clay, which, like organic matter, possesses the power of absorbing moisture and fertilizing gases from the atmosphere.

2. Inert vegetable matter is changed by paring and burning into highly effective mineral food for turnips.

3. The operation of paring and burning improves materially the mechanical condition of naturally impervious soils by rendering them more porous and pulverulent.

4. Not only does it improve the mechanical condition of the soil, but it likewise contributes to highly important changes in the chemical constitution of the soil constituents.

5. It brings within reach of the young turnip crop a large quantity of readily available mineral food from the soil.

6. The ashes produced by paring and burning are especially useful to turnips, and also to other green crops, because they contain a large proportion of phosphates and potash, constituents which, it is well known, favour in a high degree the luxuriant growth of root-crops.

7. The operation of paring and burning is applicable only on soils containing clay; in sandy soils it is undesirable, and likely to do mischief.

8. The beneficial effects of a fair quantity of vegetable ashes

upon root-crops in certain soils are more striking than the effects produced by guano, superphosphate, and other artificial manures.

9. Thin land, from which a good quantity of ashes has been obtained, should not be dressed with rotten dung, guano, or, indeed, any kind of manure. Ammoniacal manures especially should be avoided.

10. The operation of paring and burning is the most economical means for raising on certain poor soils a good crop of turnips.

11. It is therefore not likely soon to give way to other plans of cultivation on such soils.

12. Lastly, instead of being an antiquated operation, it is a practice the advantages of which are fully confirmed and explained by modern chemical science.

Royal Agricultural College, Cirencester, Dec. 1857.

XIV.—*Communication on the relative Value of Cattle-box Manure and Farmyard Manure.* By Charles Lawrence.

Having been informed that, amongst the minor contributions invited for the Journal of the Society, any analyses of matters with which farmers have to deal would be acceptable, I send three analyses of manures which I have had made at various times by Professor Way and Dr. Voelcker. Nos. 1 and 2 were made some years ago.

No. 1 is a comparative analysis I was desirous of obtaining to test the relative values of *farmyard* manure and manure from the *cattle-boxes*. My object having been a fair comparison of the value of manure made under nearly similar circumstances in other respects, I obtained a sample of manure from an open yard in which animals were being fatted, rather than from a mere stock-yard for young beasts; and the other sample was taken from my boxes.

No. 2 is an analysis of a sample of manure taken from my boxes, made at a subsequent period by Professor Way. The small proportion of ready-formed ammonia would operate unfavourably on the minds of farmers who have yet to learn that ammonia is the result of fermentation and decomposition, the *prevention* of which is a main object of the box system of feeding.

No. 3 is an analysis, made by Dr. Voelcker, of manure taken at another period, soon after it had been removed from the same boxes and heaped. Those who have not previously inspected

this system of feeding, and have had an opportunity of seeing at one moment the boxes full of the accumulation of some three or four months' manure, invariably express their surprise at the sweetness of the range of buildings; and, in a few minutes afterwards, on setting the forks to work to empty the boxes, still greater surprise at the almost instantaneous evolution of volatile gases on the admission of air to the dense compound below.

No. 1.—*Analysis of Box Manure and Yard Manure.* By Professor WAY.

	Box Manure.	Farmyard Manure.
Water, per cent.	71·4	71·0
100 parts dried at 75 to 80 Fahr. gave of *ammonia* ..	2·37	1·7
Matters soluble in water, organic and inorganic	10·7	4·6
Which left on incineration a fixed residue of	4·28	2·78

This fixed residue consisted of—

Silica..	Not determined.	
Phosphoric acid	0·30	0·26
Alkalis, potash, and soda	2·00	0·80

For the sake of showing at a glance the difference between the two manures, the results are given under another arrangement, as follows:—

	Box Manure.	Farmyard Manure.
Water, per cent.	71·4	71·0
100 parts dried at 75 to 80 Fahr.—		
Nitrogen equivalent to ammonia	2·37	1·7
Organic matter removable by water	6·42	1·82
Inorganic ditto, consisting of—		
Phosphoric acid	0·30	0·26
Alkalis	2·00	0·80
Silica, a considerable quantity, not determined	Lime and silica.	
Lime, a trace	Not determined.	

No. 2.—*Analysis of Box Manure from C. Lawrence, Esq.* By Professor WAY.

100 parts of the manure contained—

Water	72·33
Organic matter	21·80
Mineral matter or ash	5·87
	100·00

An approximative estimation was made of the relation between the straw and the real dung (both being dry), and the result was as follows:—

Straw	41 per cent.
Dung	59 ,,

The following is the analysis of the ash:—

Ash of Box Manure.

Soluble silica	27·90
Phosphoric acid	5·11
Sulphuric acid	1·11
Carbonic acid	0·95
Lime	14·41
Magnesia	2·40
Peroxide of iron and alumina	7·81
Potash	11·79
Soda	2·05
Chloride of potassium	None.
Chloride of sodium	3·82
Sand and clay	21·80
	99·15

Examined for nitrogen, the manure gave—

1st experiment	0·47	per cent. on the manure in its natural state.
2nd experiment	0·45	
Mean	0·46	

This last (0·46) would eventually produce 0·56 per cent. of ammonia. The ammonia actually existing as such in the manure was found to be ·02 per cent.

The following will be the ingredients of 100 parts of the manure:—

Water	72·330
Organic matter	21·800
Silica	1·637
Phosphoric acid	·299
Sulphuric acid	·065
Lime	·845
Magnesia	·140
Peroxide of iron and alumina	·458
Potash	·692
Soda	·120
Chloride of potassium	None.
Chloride of sodium	·224
Sand and clay	1·279
Carbonic acid	·055
	99·944
Nitrogen in the original matter	·460
Equal to *ammonia*	·560

The *sand and clay*, although in large proportion in the *ash*, only exist to the extent of $1\frac{1}{4}$ per cent. in the manure itself. The way in which this impurity is introduced will need no explanation.

A striking fact is the small proportion of *ready-formed* ammonia in the manure, only two parts of 56 being in that condition. This circumstance may be taken as conclusive evidence of the very small extent to which fermentation of the material proceeds in well-constructed boxes.

No. 3.—*Analysis of Sample of Manure from Mr. Lawrence.*
By Professor VOELCKER.

	Natural. Per cent.	Dry. Per cent.
Water	67·436	..
*Organic matter	26·806	82·318
Ash	(5·758	17·682)
Containing—		
Insoluble silicious matter	1·796	5·515
Phosphates	2·313	7·102
Equal to phosphoric acid	(1·001	3·416)
Carbonate of lime	0·282	0·866
Magnesia and alkaline salts	1·367	4·199
	100·000	100·000
*Containing ammonia ($N. H_3$.)	1·067	3·279

Cirencester, Nov. 1857.

XV. — *Elementary Introduction to the subject of Vegetable Physiology.* By ARTHUR HENFREY, F.R.S., L.S., &c., Professor of Botany, King's College, London.

PART II.

THE principal object of our former Paper (vol. xvii., page 62) was to expound, in as simple a manner as possible, the fundamental fact of vegetable organisation, namely, the transformation of fluid substances into solid structures forming parts of a living being, in the development of new cells, the microscopic elements of organic bodies, from formless substances, through the agency of the organising force residing in existing tissues. The general principles there laid down apply to all plants without exception, since the phenomena from which these principles are deduced constitute the first step both in the development of every member of the vegetable kingdom, and in every new part or organ produced by any individual plant. The primary element of vegetable structure, the cell, was described in its most general characteristics—those which are met with in all cells at certain stages of their existence.

In the following pages we propose to furnish such an account as may be intelligible to ordinary readers, of the subsequent history of vegetable cells, and to describe the most important kinds of structure or tissue which enter into the formation of plants. Since, however, the cellular textures constitute only the

framework or shell enclosing the matters in which the vitality of plants appears especially to reside, the nature of the fluids and solids contained in the cells and tissues must form a no less essential object of investigation; and indeed, as will be seen from the sequel, the study of the *cell-contents* constitutes, as regards the physiologist, by far the most important branch of the subject. In a practical point of view, above all, such questions as the history of starch and chlorophyll are of far greater importance than investigations of the forms of cells, the markings of the spiral structures, and the like, interesting as these are in other respects to the philosophic botanist. Admitting, however, the paramount importance of the contents of the cells in reference to the functions of vegetable life, it must not be forgotten that these are limited and defined in their manifestations by the laws which rule over the forms and the arrangement of the tissues, and the organs of which these constitute part. The diversity of character in the life of different plants is principally dependent upon certain fundamental differences in the plan of combination of the elements (the cells). Hence it is necessary at the outset of our inquiry to devote a few paragraphs to the consideration of the general characters of the organization of plants, before entering upon the description of the tissues and cell-contents. This will enable the reader to form juster ideas of the relative importance of the facts which will be afterwards placed before him, by setting the whole upon a more comprehensive basis.

The differences which we perceive in the outward characters of plants are accompanied to a certain extent by differences and gradations of structure in the internal parts, upon which the life of the whole essentially depends. The diversities in the internal anatomy of plants are far less striking than those which exist in the animal kingdom, as may be naturally conceived when we remember how few of the more remarkable vital functions of animals are represented in plants. Moreover, the vast variety existing in the vegetable world is rather dependent upon variations of forms and plans of arrangement (*morphological types*) than upon *physiological* differences. Hence the vegetable physiologist need not concern himself, except as to the great primary groups, with the laws and "patterns" regulating the configuration of the members of the different classes of plants. Leaving these to the botanist *par excellence*, he must especially direct his attention to the modifications of the tissues which are found combined or distributed to a great extent irrelatively, or, at all events, occur in numerous gradations within the limits of the classes whose rank is defined by the plan of arrangement of their larger organs. Let us endeavour to explain this a little more fully. The rank

which is given to a plant or animal in classification depends upon the degree to which the principle of specialization, or division of labour, is carried out in it. As the organization becomes more complicated, its parts more mutually dependent, we say it is higher; and while, in regard to physiological functions, the more the different actions are confined to distinct organs, the more exalted becomes the character of the life; so the greater diversity that presents itself in the outward form, and in the modes of combination of the organs, the higher becomes the morphological character. Now the vital functions of plants are so few in kind, and so simple, that their distribution among distinct organs only leads to a comparatively small amount of variation. The chief distinctions between the subordinate classes of plants depend upon differences of form and arrangement of organs which physiologically correspond, and are only unlike in minor particulars, to which it is difficult to assign any physiological value. Then again the structural conditions may vary almost indefinitely in complexity in the same organ within the limits of a single class in both the lower and the higher types. In the Algæ the *thallus*, or vegetative mass, presents gradations from the simple cell, or string of simple membranous cells, to the enormous frond of *Macrocystis* 500 feet in length, where the cells of which different regions of the thallus are composed, exhibit considerable differences both in their forms and functions. Among flowering-plants we find, in the same monocotyledonous class, the palms with their magnificent organization, and the duckweed of our pools, in which the physiological functions are performed by organs constructed on an analogous type, but in the latter case almost rudimentary in their internal organization.

From these considerations it becomes evident that there can be no serial arrangement of vegetable forms in a single graduated scale. We do indeed find a progressive complexity or perfection in the types or plans which characterise the great classes; yet these do not run into one another, but rather stand side by side, exhibiting corresponding gradations, or running out from a common centre into radii of different length.

The vegetable kingdom falls very naturally into two great sub-kingdoms or regions, characterised at once by the outward form (morphologically), by an essential diversity in the internal structure, and by the different degree of specialization of the functions (physiologically). In the lower group we can find no physiological distinctions in the structures devoted to the vegetative life, the general mass of cellular tissue carrying on in common the processes of absorption, digestion, respiration, and development. In the higher group there exists, well-defined in

almost every case, a distinction between the absorbing organs (roots), the digestive and respiratory organs (the leaves), and the organ which at once serves to connect these together, and constitutes the focus of development (the stem). This distribution of labour is accompanied, from the lowest forms in which it appears, upwards, by the coincident occurrence of a kind of tissue absent in the lower group; the fibrous and fibro-vascular cords which, connected together and arranged in various ways in the stems, form a bond of union between the organs, and, in the more highly developed plants, constitute a skeleton or framework to support the almost indefinite products of the vital activity of the properly cellular tissues.

The first group are called Thallophytes, from *thallos*, a Greek word signifying a vegetating shoot, and *phyton* a plant. The vegetative structure consists of a homogeneous mass, such as we see in the fronds of Sea-weeds or the scaly patches of the Lichens; and as this vegetative mass or layer is exclusively composed of cells comparatively little changed from their primary conditions, these plants are sometimes distinguished as Cellular plants. The cellular tissue does indeed exhibit very considerable diversities and a considerable range in the degree of alteration from the original form of a membranous sac, as is evident when we compare the simple confervoid filament with the larger Sea-weeds, in which there is a distinction into cortical and medullary tissues, evident both from the form and texture of the cells. But the thallus never presents any trace of those specially metamorphosed and regularly arranged masses of elementary tissue which constitute the fibro-vascular cords of the higher groups.

A most important kind of gradation does, however, present itself within the limits of the Thallophytes, dependent on a matter which we have not yet touched, namely, the specialization of cells in reference to the reproductive functions. In the very lowest forms, as in the fresh-water Algæ, the same cells form in the early part of their existence the organs of vegetation and growth, and at a later period give up these functions and undertake the production of the *spores*, the germs of new individuals for the reproduction of the species. Step by step, in more complex forms of Algæ, the reproductive functions become more localised, at first in certain selected cells of the vegetative mass; afterwards the reproductive cells are found marked for their special function from their very first origin; and in the highest forms, portions of the thallus are developed into peculiar *fruits* or *receptacles*, enclosing and protecting the reproductive cells. These distinctions in the reproductive structures are of great importance in the eyes of the botanist and of the physiologist; but their interest is almost exclusively scientific, and they bear

upon practice chiefly through affording instructive illustrations of phenomena of reproduction occurring in an analogous manner in the higher plants, where they are less accessible to direct observation.

The higher of the two groups founded on the characters of the vegetative system comprehends all plants possessing a stem or *axis*, bearing leaves above and roots below, presenting therefore two diametrically opposite directions of growth. The distinctive name of *Cormophytes* has been applied to these, from the Greek word *kormos* a trunk or stem, and *phyton* a plant; the term *Vascular plants*, as contrasted with *Cellular plants*, is likewise applicable to all but the lowest orders. In the simplest members of this sub-kingdom the fibro-vascular structures are present, but represented by elementary organs presenting little variety of conformation ; thus in the Mosses they constitute a simple fibrous cord running through the centre of the stem, giving off branches which sometimes run into the blades of the little leaves, but more frequently are confined to the stem, so that the leaves are mere cellular plates like the fronds of the stemless plants. In the Ferns and allied plants there is a great advance, the general characters of the stems and leaves approaching those of the flowering plants ; but the inferiority of organization indicated by the absence of flowers, and the intimate connexion of the reproductive structures with vegetative system (evident in the formation of the *spores* on the ordinary leaves of Ferns), correspond to a much slighter diversity and complexity in the conditions and arrangement of the fibro-vascular elementary tissues.

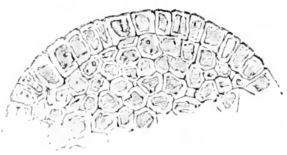
In the Flowering-plants, in the two large classes called the Monocotyledons and Dicotyledons, the different plans of arrangement of the fibro-vascular structures cause a totally different mode of growth of the stems, forming perhaps the most strongly-marked of the characteristics by which these classes are distinguished.

As in the Thallophytes, however, the most important diversities of the sub-kingdom of Cormophytes lie in the mode of development and arrangement of the reproductive organs. In the progressively higher orders these become step by step extricated from their connection with the vegetative system, until in the Flowering-plants we find the organs which produce the reproductive bodies (*seeds*) associated with a complicated collection of specially-metamorphosed organs (sepals, petals, stamens, &c.), while the germs produced are no longer thrown off as simple cellular bodies, but remain dependent upon and nourished by the parent plant until they have acquired their own stem, leaves, and root—that organization, in fact, which distinguishes the vascular stem-forming from the cellular or stemless plants.

The great number of distinct parts, the manifold difference of texture, provision for long duration, &c., involved in the existence of flowers, seeds, and fruits of almost endless variety of character, give occasion, as must be evident, to very great multiformity in the conditions of the fully-developed tissues in the highest class of plants. Among these there are some far more important than others in reference to their connexion with peculiarities in the processes of cell life; and we shall select for consideration here only those principal forms of the fully-developed cell, with which it is indispensable for the vegetable physiologist to be intimately acquainted. We hope hereafter to be enabled to illustrate the general physiological anatomy of the organs of vegetation and reproduction, in a history of the development of the most important agricultural plants.

As the cells of all plants originate in a similar manner, and are essentially alike in their earliest stages of growth, young organs of plants, and their *growing points* or *regions*, are universally composed of a similar tissue, which may be termed *nascent* or *cambial* tissue, constituting as it were the raw material out of which all the special tissues are developed. The cambial tissue, as found in the apex of buds and roots, in the growing regions of stems and other organs, consists of a closely-packed mass of delicate membranous cells gorged with nitrogenous formative matters (fig. 1), and, according to circumstances, with or without starch, chlorophyll, or other assimilated matters and products intermixed with them. Cells in this condition carry on the *development* of the plant by repetitions of the process of *cell-division*, described in our former Paper (vol. xvii. pp. 79, 80). As the cells of the cambium-tissue multiply, the structure increases in size; and in order that a definite form should be given to the product, the cell-development takes place only in certain definite directions. Thus the formative energy is carried onwards with the advancing points of growth, and the tissue which it leaves behind constitutes the substance of the new organs. In the bud of a palm-tree, for example, the summit is occupied by a mass of cambial tissue, in which the cells continually multiply, advancing the growing point, and leaving behind them the cellular substance forming the body of the trunk, together with the lateral masses thrown out from time to time to form the leaves,

Fig. 1.



Section of the border of a nascent leaf from the centre of the bud of the cabbage. The cell-walls are scarcely visible until iodine is applied, which coagulates the protoplasmic contents and causes them to contract and leave the walls. Magnified 400 diameters.

which run through a peculiar course of development of their own. In our ordinary trees the cambial tissue is not confined to the growing points or buds, but it extends as a layer all over the surface of the stem beneath the bark, forming the seat of the annually-repeated development of wood by which the plants of this order acquire their often so enormous dimensions.

In the cells left behind by the advance of the formative energy in the growing points, or detached from the main body as the foundations of lateral organs (leaves, &c.), it next becomes a question of the first importance, whether they are destined to form the seats of active physiological processes, or are to form parts of the structures by which the physiologically active tissues are protected or supported, or through the medium of which a communication is to be established between the active cells of the different organs and regions. If they are to be devoted to the first office, their physical characters undergo comparatively slight changes: increase of size, and perhaps alteration of form, being the principal affections to which they are subject. They likewise continue to possess the formative and assimilated matters which existed in the young cells; and indeed their life is essentially devoted to the production and conversion of these substances, to supply the waste taking place in the cambium regions, or in the formation of fruits, and to furnish material for the consolidation of the permanent structures of the plant. This *parenchymatous* tissue forms the mass of almost all the structures most important to agriculturists; and in root culture and green crops especially, it is the object of cultivation to increase its quantity relatively to the other tissues. The soft, succulent substance of leaves, of herbaceous stems, and of tuberous roots, of pulpy fruits, &c., is mainly composed of such tissue; and while in a state of active vegetation, its cells are always loaded with the assimilated matters, rendering these productions highly nutritious to animals.

It is important, however, to notice that these cellular or parenchymatous tissues are *transitory* structures. In the natural course of events leaves fall, tuberous roots shrivel up, and succulent fruits fall off and rot. They are developed as temporary nourishing agents, or as reservoirs for accumulated nutritive substance; and nature is too economical to leave the acquired stores in them after the duty is performed. Long before leaves fall off the chief proportion of the assimilated matter is removed from them: the roots of the turnip and beet contain very different qualities of cell-contents in the months before and after their winter rest. And even during the active seasons of growth, if the development, but above all the expansion, of the succulent tissues is stimulated by free supply of heat and moisture, without a proper amount of

air and light to insure thorough assimilation, the formative contents of the older cells are carried away to supply material for new growth, or become *diluted* as it were in the unnaturally-expanded cells, and the result is the production of a weak, watery mass of tissue. The more minute consideration of these points must be reserved until we come to speak of the cell-contents.

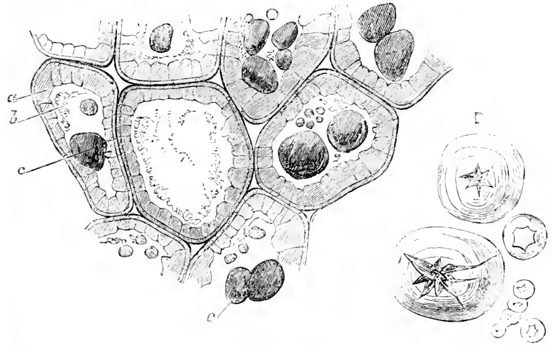
We have said that in the succulent tissues the cells become little altered except in form and dimensions; but even in the most delicate of these tissues the membranous 'cell-wall' acquires a certain increase of solidity beyond its original condition. The degree of expansion of each cell of any tissue, being confined within certain limits, the nutrient agency of the formative layer lying upon the internal surface is subsequently directed to the increase of thickness of the membrane, which is effected by the application of new, delicate lamellæ upon the inner surface of the primary membrane, intimately adhering to it. In ordinary cellular tissues these layers of thickening are thin and few in number, and could hardly be detected were it not that they are to a certain extent incomplete, leaving certain spots of various forms of the primary membrane uncovered, which thinner places appear like holes or slits in the cell-wall, although this is not actually perforated. These thinner places occur chiefly on parts of the cell-wall adjacent to other cells, and appear to constitute a means of facilitating the passage of fluids from the cavity of a cell into those of its neighbours. In certain cases the layers of thickening are more numerous, giving a far more solid character to the tissue, which still retains its succulent character; this is especially observed in the cells of fleshy leaves, in the parenchyma of the rind, or of the pith of annual shoots of particular plants, &c.

From cells of this character it is but a step to those which are met with occasionally in organs of transitory duration, which retain the parenchymatous form and active vital functions, while their walls become greatly altered in character. This is the case in certain organs where the cellular tissue is organized as a reservoir of accumulated nutriment, to preserve this during a season of rest, but where this nutriment is laid up, not in the cell-contents, but in great part in structures belonging to the cell-wall. The starch of the wheat-grain, or of the potato tuber, is laid up in delicate membranous sacs, cells which preserve all their original characters as regards the condition of the 'cell-wall.' But the seed-lobes of the bean and pea, the 'endosperm' of the onion seed and of many other plants, are composed of tissue in which the cells have their walls so greatly thickened that their cavities are comparatively small, and the coherent mass of cells acquire a fleshy or horny texture (fig. 2). It may be mentioned

in passing that a similar condition exists in the cellular structure of the cartilaginous Sea-weeds; for instance in the caragheen

Fig. 2.

A



A, Section of the cotyledon of a white haricot bean, showing *a*, the soft thickened cell-walls, which are coloured light-blue by solution of iodine; *b*, the protoplasmic or albuminous substance in the cells, coloured yellow by iodine; and *c*, the starch-granules, coloured deep blue. Magnified 200 diameters.

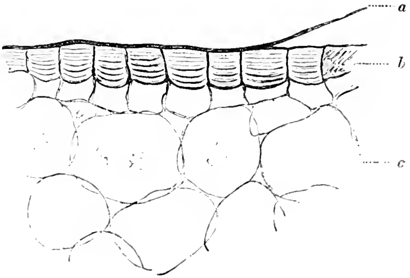
B, Loose starch-granules, the larger having the striæ, with a central cavity sending out radiating cracks. Magnified 400 diameters.

or 'Irish moss,' and in Lichens, where the thickening of the walls of the constituent cells converts the whole into a soft horny substance, in which the cavities of the cells occupy comparatively little space. The thickening layers of these tissues are, however, distinguished by their peculiar consistence; they appear to be formed of a modification of cellulose approaching to starch, for not only are they readily softened and dissolved by acids, and sometimes capable even of assuming a blue colour with iodine, like starch, but on the recommencement of vegetation (germination of the seeds) they are, like the starch of wheat or the potato, attacked by the nitrogenous formative layer, which had previously formed them, re-dissolved, and more or less completely removed and conveyed to the developing regions of the young plant.

Structurally related to the foregoing, although very differen in their physiological relations, are the cells of the tissue called *epidermis*. So soon as any rudimentary organ of one of the higher plants has attained a distinct form, the layer of cells which form its boundaries, those constituting its entire surface, come into close union at their sides, and, assuming a special mode of increase and expansion, present themselves in the perfect

organ as a continuous layer, forming a kind of skin completely investing and perfectly enclosing all the succulent structures, &c. The cells of this layer do not participate in the vital activity of the succulent tissue, and, when complete, are found filled with simple watery fluid, seldom containing starch, colouring matter, or the like, which exist in the subjacent parenchyma. In the great majority of plants that side of the walls of the epidermal cells which is turned towards the external air becomes thicker than the other sides, this being the case to a greater or less extent in different cases, in excessive instances giving the hard horny character to the surface of the leaves observed in many evergreen plants. This thickening results from the deposition of new lamellæ of cellulose on the inside of the exposed wall, which deposition may go on until the cavity is nearly filled up and the cell converted into a solid body (fig. 3). Upon leaves and young stems the thickening layers are generally formed of hard cellulose, obstinately resisting decomposing agents; but the epidermis of many seeds, although of great solidity, has the cells thickened or filled up by lamellæ of a less resisting modification of cellulose, as we see in the horny skin of the seeds of beans, and still more remarkably in the skin of the seed of the quince

Fig. 3.

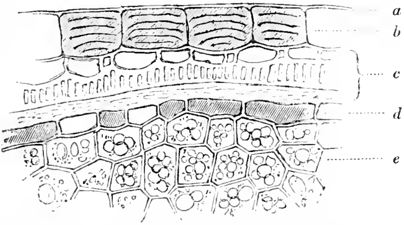


Perpendicular section of the epidermis or skin of the leaf of the garden hyacinth, soaked in solution of potash: *a*, the pellicle (never coloured blue by iodine), apparently formed by the chemical alteration of the outer layer of the wall of the cells; *b*, the lamellæ thickening the side of the cell next the surface; the laminated structure is invisible when fresh, and they then are coloured yellow by iodine, but after the action of potash the lamellæ become distinct, and are coloured blue by iodine; *c*, the subjacent cells of the leaf. Magnified 400 diameters.

and linseed (fig. 4), where the cells are thickened by lamellæ of a gummy consistence, which softens and swells up in hot water like the tissue of the seed-lobes of the bean and other leguminous plants. Still further alterations of the epidermal cells, dependent chiefly on chemical operations, as the formation of resinous or

waxy excretions, and the impregnation of the membrane with silica, will be spoken of more conveniently hereafter.

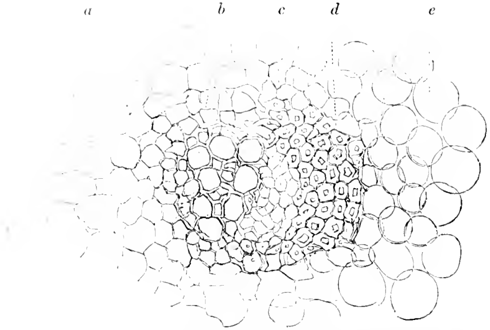
Fig. 4.



Perpendicular section of the outer part of a grain of linseed: *a*, the cuticular pellicle; *b*, the epidermal cells filled up by laminated deposits of the substance which dissolves into a jelly; *c*, subjacent layer of cells of the seed-coat partly obliterated by pressure; *d*, layer of cells containing albuminous substance; *e*, cells of the endosperm, containing drops of oil and granular protoplasm. Magnified 350 diameters.

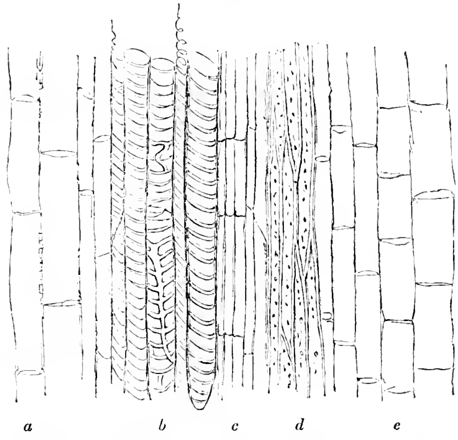
In the lower Cellular plants the fluids conveying nutriment appear to be diffused with great uniformity throughout the whole structure. In plants possessing a stem, and in particular in the Flowering plants, with which we are more especially concerned, the fluids absorbed by the roots flow up in determinate courses through tracts of a tissue which differs in important respects from the parenchyma above described. The cells lying in these tracts exhibit at a very early period a peculiarity of form; they become elongated, and more tubular than sac-like; and if examined in young shoots or stems they will be found to contain colourless matters, while the surrounding parenchyma abounds in chlorophyll, &c. At a very early period of their existence, moreover, the character of a portion of these cells becomes very distinctly marked by the alterations which take place in the cell-wall. Secondary deposits or layers of thickening are formed upon the walls, in lines which have a more or less distinctly spiral course, so that the new substances form spiral bands or ridges upon the inside of the tubular cell, visible externally through the transparent wall; very often this thickening occurs, especially in the larger tubes, in the shape of rings, or of rings or spiral coils connected into a kind of net-work by cross pieces (fig. 5). Cells of this character, more or less elongated, occur in the ends of young shoots of ordinary trees, forming the rudiments of the wood, extending out in bundles into the leaves and other organs as the principal constituent in the ribs and veins, which indeed, in the parts of the flower, are chiefly composed of these 'spiral vessels.' The slender threads traversing the spongy substance of the leaf-stalk

Fig. 5.



A cross section of one of the fibro-vascular bundles of the stem of the white lily: *a*, cellular tissue (next the centre of the stem); *b*, spiral and other vessels and ducts; *c*, cambial or sap cells; *d*, liber cells; *e*, cellular tissue next the rind.

Fig. 6.



A perpendicular section of the same, giving a side view of the cells and vessels. The letters with the same signification as in the upper figure. Both magnified 100 diameters.

of rhubarb are almost wholly composed of cells containing these spiral and annular layers of thickening, and afford a very convenient opportunity of studying their characters; they may also

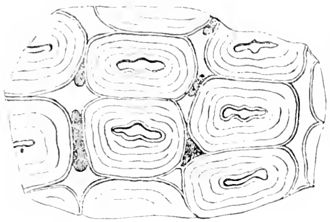
be seen *in situ* by placing delicate petals, such as those of common chickweed, under the microscope.

It is well ascertained that these tubular cells with spiral or analogous markings lose their fluid contents at an early period; they are always found filled with air or gas when observed in a fresh state, except in the very early stages of development: hence the name of '*vessels*' generally applied to them must not be taken as indicating that they convey fluids like the tubular vessels of animals. They are sometimes called *tracheæ*, as though they represented the respiratory tubes of insects, to which they bear a superficial resemblance. To attribute to them any share in the functions regarded as respiratory in plants would be a great assumption in the present state of our knowledge. Perhaps the most plausible view that can be taken of their use is to regard them as constituting a flexible framework or skeleton, combining strength and lightness, forming a support to the delicate tubular cells with which they are associated, in which the currents of sap appear to flow.

In very delicate organs, such as petals, and in very young stems, &c., the veins, ribs, or 'vascular bundles,' consist of spiral-vessels and allied forms, with the elongated sap-tubes. Such structures form the rudiments of the solid fibres which run out into well-developed leaves, and are combined within the stem into the firm structure constituting the wood. A considerable difference exists in the arrangement and mode of development of these structures in the two principal classes of the Flowering plants—those with a one-seed-lobed embryo, called Monocotyledons (grasses, asparagus, onion, &c.), and those with a two-seed-lobed embryo, called Dicotyledons (bean, turnip, flax, &c.). In the Monocotyledons the vascular bundles remain always isolated, as at first, traversing the stem as separate fibres, as may be seen in cutting across a stem of asparagus, or of the white lily (fig. 5); in the Dicotyledons the bundles, which are developed in a circle, soon come in contact side by side, and form a tube of solid substance separating the pith from the rind or young bark. The causes of these differences cannot be conveniently explained here; and we hope to have a better opportunity hereafter, when we carry on our inquiry into the special examination of the structure of the organs of the more important cultivated plants. The young vascular bundles, as we have said, consist of spiral or similar vessels, with a bundle of tubular cells (sap-cells, figs. 5 and 6, *c*), still in the cambial condition. When fully organized, the greater part of the cambial structure developed in the early stages is converted into wood, or liber-tissue (*d*), which results from the thickening of the walls of those cells by secondary deposits. These layers of thickening are developed in great numbers in

many kinds of wood, so that the originally tubular cells become almost solid cylinders, in which state they are sometimes called woody fibres (fig. 7). The liber-cells, forming the woody structures of bark, are much longer in proportion to their diameter than the cells of wood, and from their great solidity when fully developed are often called 'liber-fibres.' The wood-cells, and also the liber-cells to less extent, have their walls marked, by the absence of the thickening layers at certain spots, and a great variety of conditions of these 'pits' or dots occur in the woods of different trees; it is altogether unimportant for our purpose to dwell upon these. It may be mentioned, however, that the wood of most Dicotyledons contains, scattered in the substance of the bundles, large canals formed by perpendicular cells of cylindrical form coalescing at the ends, so as to form a continuous tube. The spiral and annular vessels of fully developed bundles coalesce in a similar way at their ends, and the jointed tubes formed in this way are often called 'ducts.' These 'ducts' are often so large that they constitute tubular channels visible to the naked eye, as may be seen in the wood of oak, mahogany, &c., and likewise in the Monocotyledonous cane, the stem of a kind of palm. The use of these ducts is unknown; in ordinary conditions they contain air, and perhaps they may be regarded as contrivances to lighten the woody structure, and to serve at the same time as 'safety-tubes' into which the fluid contents of adjoining cells may be poured out when the tissue is gorged with sap.

Fig. 7.



Cross section of wood of the Scotch fir, showing the ends of a number of wood-cells. The section having been heated in nitric acid, they are partially separated, and the concentric lamellæ of their walls have become visible. Magnified 400 diameters.

Diverse as we find the forms and the physical conditions of the cell-membranes and their thickening layers in the various tissues of the higher plants, they have a fundamental identity of composition. In all cases they are originally composed of *cellulose*, a substance having a definite chemical constitution, and which is recognizable by certain characters of reaction which can be applied to the tissues under the microscope. The analyses of cellulose show that it is most intimately related to starch, and it is well known that starch acquires a blue colour when it is brought in contact with iodine, a fact which is of great value to the vegetable anatomist in enabling him to detect the existence of starch in the

tissues of plants. Cellulose may be recognised by a reaction nearly connected with the above; for when iodine is applied to it either alone or more readily when in conjunction with sulphuric acid, the cell-membrane in certain conditions also assumes a blue colour. The chemical actions which take place here are not yet explained; but the test is an invaluable one, as it is found to have almost universal application throughout the vegetable kingdom. The cell-membranes of some Fungi appear at present as the most important examples of an exception. The connexion of starch and cellulose is indicated both by their elementary chemical analyses and by the above reaction. The reaction with iodine is generally most strikingly displayed in the earlier or little altered conditions of the cell-walls. The excessively delicate membrane of the nascent cells of some Confervæ (*Œdogonium*), and also the very recently-formed layers of thickening in the older cells of these plants, assume a blue colour when treated with iodine alone, much lighter than would be the case with starch, but of the same kind. A similar sensibility to this action of iodine alone exists in the semi-gelatinous layers of thickening in the cotyledons or endosperm of certain seeds (for instance, in certain leguminous plants), where, as was explained above, the thickening matter of the cell-wall is a transitory structure, and is redissolved during germination and appropriated as food, like starch existing in such seeds as cereal grains. But the cell-membranes of parenchymatous tissues generally may be coloured blue by saturating them with strong tincture of iodine, and then wetting them with water. In the same conditions of the cell-wall the application of sulphuric acid, in company with aqueous solution of iodine, brings out the blue colour much more readily. This latter reaction affects almost all membranous cellulose, either of fresh structure or in a dead condition, and may be easily observed under the microscope by wetting a few filaments of cotton wool with somewhat diluted sulphuric acid and adding solution of iodine.

Many old cell-membranes, together with the harder woody tissues in which the cell-wall has received deposits of solid thickening substance, and the thickened cell-membranes of epidermal structures, display a different character when treated with sulphuric acid and iodine. Under these circumstances they assume a deep yellow or brown colour. The observation of their development shows that this character is gradually assumed, and that the same lamellæ, which were capable of taking a blue colour when young, lose this peculiarity as they grow older, and even that in some intermediate stages they may acquire a dirty greenish tint. It becomes a point of importance to ascertain the nature of this change, since it might be attributed to a chemical conversion of the old cell-wall into a substance different from cellulose,

or it might be supposed to arise from the cellulose layers becoming infiltrated by substances which disguise its reactions. The latter view is that which is most favoured by the evidence yet obtained. It is found that the structures most obstinately refusing to assume a blue colour with sulphuric acid and iodine, may be brought into a condition, without losing their recognisable anatomical characters, in which they react with tincture of iodine (without sulphuric acid), like young cellulose. A difference presents itself here in the behaviour of two classes of tissues, very differently placed as regards their relation to atmospheric agencies, which may perhaps influence their characters. The structures belonging to the epidermis present a marked difference from those belonging to the internal woody tissues.

In the cells of well-developed epidermis, cork and the cork-like tissues of bark, iodine and sulphuric acid colour the cell-membrane brownish-yellow only. But if sections of these structures are soaked for a long time, or boiled for a short time, in strong solution of potash, and well washed, they are brought into a state (the structure being undestroyed) resembling young cellulose, for if soaked in tincture of iodine, dried, and then wetted with water, they acquire a bright blue colour. Potash will not bring about this change in the cells of wood and fibrous tissues, but nitric acid will; nitric acid on the other hand will not, as a rule, affect the epidermal tissues. Sections of wood, liber, or other structures, where the cells possess firm ligneous walls, assume a yellow or brown colour with sulphuric acid and iodine. When such sections are boiled in nitric acid so long that the yellowish tint, which this acid gives at first, gives place to a bleaching, the tissue is changed, as in the above process with potash. After neutralizing the acid with ammonia and washing away the salt then formed,—saturating the object with tincture of iodine, drying, and then adding water, brings out the characteristic blue colour of cellulose. This possibility of bringing all the solid tissues of plants, in any condition of development, into a state in which they exhibit the reaction of pure cellulose, still retaining their anatomical structure, affords good ground for the assumption that cellulose forms the universal basis of the substance of vegetable tissues, and that the diverse conditions met with in the different parts of plants, and at different ages, depend upon different degrees of consolidation of the substance, admitting a more or less free access to the iodine, and, in the older tissues, to the infiltration of the membranes with foreign substances, which still more strongly oppose the interference of the iodine, and themselves give the yellow colour which iodine and sulphuric acid produce.

It may be worth while to advert briefly here to a certain real metamorphosis of the cellulose membrane. The superficial

lamellæ of epidermal-cells, in contact with the atmosphere, appear to be always chemically changed into a substance of resinous or waxy nature, which remains unaffected or is dissolved by the above reagents (fig. 3 *a*). This conversion takes place to a very great extent in some instances, especially in certain fruits, where the transformed lamellæ form a distinct waxy investment, giving the so-called 'bloom' of plums, grapes, &c. The silica which exists in the epidermis of the grasses and other plants, appears to be an impregnation of the outer lamellæ of the cell-wall, hardened in their substance, and not a deposit inside or outside the walls of the cells.

We have now to enter upon the examination of the more important contents of vegetable cells, which, as was shown in our former paper, possess the highest interest for the physiologist, and as they include the principal nutrient substances furnished by plants, must be an especial object of inquiry in reference to agriculture.

Among the cell-contents we find fluid and solid substances, and some of intermediate consistence. Of these latter, the *protoplasm*, or *formative matter*, is a substance of the first importance. It was shown in our sketch illustrating the ordinary modes of development of cells, that the production of new cells depends upon this substance, and it was at the same time indicated that it takes a principal share in the production of all the other contents of the cells—that, in fact, it is to be regarded as peculiarly the vital part of the structure.

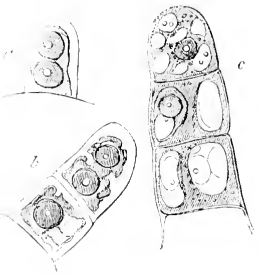
The example selected for illustrating the process of cell-division, the Confervoid filament (vol. xvii. page 79), was chosen on account of the process occurring there in a modification far more accessible than usual to direct observation, both on account of the size and the anatomical condition of the parts. The process takes place in a manner essentially similar in the higher plants, and the young cellular hairs of Flowering plants present a condition very like that of the Confervoids. But in these and still more in the cambial tissues of buds, of nascent leaves (fig. 1), rootlets, and other organs, the cells are excessively small, and so crowded together that the observations are rendered very difficult.

Where the cells are so very small at their birth, and their subdivision is repeated rapidly before they have time to expand, as in the nascent organs just referred to, the protoplasmic matters exist in a state rather different from that in the large tubular Conferva-cell: entirely filling up the cavity of the minute cell, instead of forming a layer lining the cell-wall, so that the constriction here effects simply the parting of one mass of formative

substance into two or more, each mass forming its own new cell-membrane (fig. 8, *a*).

It becomes requisite here to direct attention to a body almost invariably existing in young cells in connexion with the protoplasm, and persisting throughout the life of many parenchymatous tissues, namely, the *cell-nucleus*, to which some physiologists attribute the highest importance in the origination of cells, but the real office of which is not yet ascertained. The nucleus (fig. 8) is a body usually of a lenticular form, or the shape of an old-fashioned watch, composed, so far as can be determined by tests applied under the microscope, of the same substance as protoplasm. In full-grown cells where it occurs, it either lies upon the inside of the formative layer (*primordial utricle*), or is connected with this by threads of viscid protoplasm (*c*), holding it suspended in the cavity of the cell. The relative size of the cell-nucleus and the full-grown cell will be best understood from the drawings (fig. 8). It is found that where the cell-nuclei exist in cells in course of multiplication, the first step of the process is the division of the nucleus into two (or, as some affirm, the solution of the nucleus and the formation of two new ones). Such a process even forms the forerunner of the division in *Spirogyra*, described in our former paper, where the drawing (fig. 7, page 79 of vol. xvii.) shows the two nuclei suspended by protoplasmic threads in the central cavity.

Fig. 8.



Very young hairs from the surface of buds of *Achimenes*: *a*, the hair, a conical cell filled with protoplasm (retracted from the wall through the action of water), containing two nuclei, which nearly fill it; *b*, an older hair, in which the upper part resembles the cell *a*, while the lower is more developed; *c*, a more advanced form, composed of several cells which have expanded considerably, the protoplasm which originally filled the cavity being now "honeycombed" by cavities filled with watery cell-sap; the nuclei adhere to the strings of protoplasm which stretch across the cavity of the cell, and are all connected with a thin layer lining the cellulose wall.

But the relations of the nucleus and its divisions, whatever may be their import, are seen most strikingly in the development of the minute cambial cells of the higher plants. In these the nascent cells are often scarcely larger than the nuclei, which are formed nearly of their full size in the parent-cell before division. This is very well seen in epidermal hairs, where the successive stages of development are presented at one view (fig. 8). In the end cell the nucleus (or a pair of nuclei, if division is about to be repeated) nearly fills the young cell, the formative layer being represented by a thin stratum of viscid protoplasm

between the nucleus and the cell-wall. As the cell-wall expands, it departs further and further from the nucleus, which never increases much in size; meanwhile more protoplasm is formed to fill up the intervening space, and this continues up to a certain point. Then a new phenomenon presents itself; in the protoplasm appear lighter spaces, cavities filled with a thinner fluid, which thus look like " bubbles" in the protoplasm; sometimes these increase in number as well as size, and give the protoplasm a frothed appearance; in other cases only one large cavity is formed, which gradually and equably enlarges. When many of the water-spaces exist, as they expand they coalesce more or less: but remnants of the thick protoplasm forming the boundaries of the spaces remain as viscid threads stretching across the central cavity; in this way are formed the threads by which the nuclei are often suspended; in the other cases the nucleus is carried out with the main body of the protoplasm, which by the expansion of the water-space is pushed out, and always adhering to the cell-wall, forms a thicker or thinner layer investing this, presenting the same character as the lining layer of the Confervæ, the central space, occupied by watery-cell sap, forming the great cavity of the cell. The protoplasm is, however, much increased in quantity during the expansion of the cells of succulent parenchymatous tissues destined to form the seat of nutrition, especially in leaves and other green parts, also in cells which are destined to produce starch. In leaves we find a rather thick layer applied against the cell-wall (fig. 9), in which it is not easy to ascertain whether a distinct (formative) layer lies immediately upon the cell-wall; the protoplasm is of denser consistence near the cell-wall, and when contracted by re-agents presents a smooth, even surface where it was in contact with the membrane. In some of the Cellular plants the character of the protoplasmic layer is more distinctly seen, and it there presents an appearance of distinct layers, of different consistence, the densest next the cell-wall. The layer immediately applied to the wall seems to be efficient in cell-formation, while the inner thicker layer is more devoted to the nutrition, judging from the chlorophyll-granules which lie imbedded in it. In the *Chara* the circulating substance is a third stratum, lying inside that layer in which the chlorophyll-granules are imbedded. In the cells of the leaves of Vallisneria, the chlorophyll-granules are imbedded in a rather thin layer of transparent protoplasm, which extends as a sheet over the inside of the cell-wall, and "circulation" observed in the cells consists in the travelling round of the entire stratum of protoplasm, carrying along the chlorophyll-granules and the nucleus with it; by which indeed the motion is rendered visible.

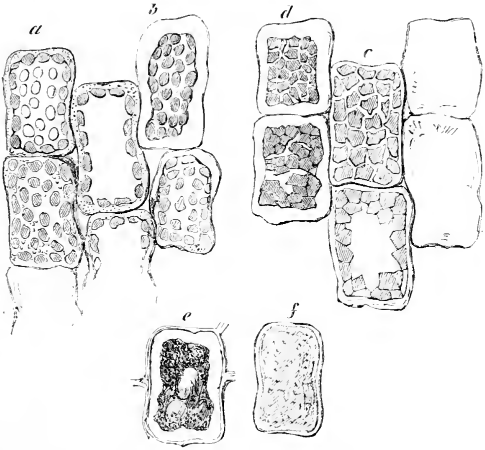
The circulating movement of the protoplasm in the interior of cells is observed in many young cells, and may perhaps be universal in early stages of growth; but in most nascent tissues it is difficult to get an observation without injuring the structures so much as to disturb the internal economy of the cell, through endosmotic or exosmotic actions. It may be seen very well, however, in young hairs of Flowering plants, which, projecting from the epidermis of organs, may be examined without the necessity of dissection. In these the movement is seen in the protoplasm lining the walls, and in addition, the viscid threads which run across the cavity and connect the nucleus with the primordial utricle move about, change their form, and carry along the nucleus with them. The protoplasm is usually almost colourless in these cases, and the motion is only rendered visible by the presence of minute granular matter which always exists in the protoplasm. These movements cease very early in plants growing in air, but they persist in the cells of many water-plants, where the movement may be seen not only in the transparent young organs, but in sections of the full-grown leaves, &c., where the presence of chlorophyll-granules above referred to renders the movement very evident.

It has already been shown how important the protoplasmic cell-contents are in reference to the formation of cells (vol. xvii. p. 78 *et seq.*), and we shall have presently to direct attention to the evidence of their agency in producing the various other substances which are met with in living cells. But protoplasmic substances are not only accumulated in the cells for the purposes of reproduction or nutrition of the individual cell in which they occur; we find tissues in what we may term the "resting" structures of plants, wherein the cells are loaded with a store of protoplasmic matter to serve as material for future wants. This is especially the case in seeds, buds, bulbs, tubers, and the like. The outer layers of the cells of the endosperm of the corn grains, beneath the hard skin, and the cells in the vicinity of the embryo, contain no starch, but are filled with protoplasmic nitrogenous matters in the form of globules or granules of semifluid consistence (fig. 11). A small quantity of this same substance exists with the starch in the inner cells. A portion of the cells of the embryo of beans (fig. 2) and pease exhibits a similar character, and this accumulation of assimilated nitrogenous matter is a constant phenomenon in seeds. As will be shown hereafter, this matter is removed from the cells and consumed by the young plant during germination.

None of the substances met with in the contents of cells have greater claim to the attention of the physiologist than *chlorophyll*,

or "leaf-green," as it is sometimes termed. It is well known that the characteristic green colour of vegetation depends upon the presence of this substance; further, that its production is entirely dependent upon the action of sun-light on the contents of cells, and that its formation under this influence is directly connected with the evolution of free oxygen, the result of a decomposition of the very highest importance in the nutrition of plants. Although, however, it has been experimentally ascertained that the formation of the green colouring matter takes place in consequence of an action of the sun's light, and that the quantity in a given plant is as a rule proportionate to the amount of this action, great obscurity prevails when we attempt to go below the surface of these general statements. Moreover, although we see every day that the formation of the solid structure of plants, and of the more highly elaborated products rich in carbon, bears a relation to the activity of the chlorophyll-forming process, it is at present quite unsettled what that decomposition is which gives rise to the formation of the green colouring matter. Added

Fig. 9.



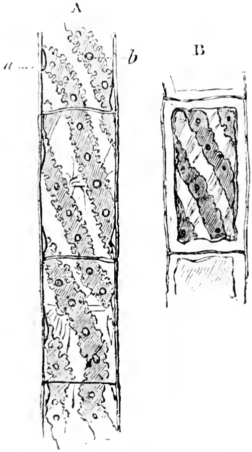
Cells from the middle substance of the leaf of a grass (*Poa*): *a*, in a natural state, the chlorophyll-granules imbedded on the outside in the layer of protoplasm lining the wall of the cell; *b*, a cell with the "primordial utricle" contracted, bringing away the chlorophyll-granules from the cell-wall; *c*, cell in which the green colouring matter has been extracted from the chlorophyll-granules by alcohol; *d*, similar cells with the "primordial utricle" contracted by tincture of iodine; *e*, cell treated with a solution of potash, converting the whole contents into a green granular viscid mass contracted from the cell-wall, but hollow internally; *f*, a cell treated with acetic acid, the contents entirely converted into an olive-coloured fluid containing minute point-like granules. Magnified 400 diameters.

to this, very superficial and incorrect notions prevail widely as to the physical and chemical qualities of chlorophyll, and its developmental relations to the other substances occurring in cells.

Chlorophyll is ordinarily found in the form of rounded granules, flattened in one direction, lying imbedded in the layer of colourless protoplasm lining the cell-wall. In this condition it may be readily observed in the internal cells of the leaves of the grasses (fig. 9, *a*), and even more clearly in the cells of the leaves of the water-plant Vallisneria. The depth of the colour and the number of granules vary according to circumstances, both being increased by active solar influence. When the granules are so numerous that they are crowded together, they often assume a hexagonal form, so as to fit closer together, but even when thus crowded, they are not immediately in contact, a thin layer of the colourless protoplasm being always interposed between them.

When fully developed, chlorophyll is ordinarily granular, and situated as described upon the wall of the cell, but there are exceptions to this rule, especially among the flowerless plants, where the chlorophyll sometimes occupies the centre of the cell, surrounding the nucleus, and sending out radiating processes (*Anthoceros*), while in other cases it presents itself in the form of bands and streaks running over the cell-wall, quite distinct from the layer of protoplasm immediately applied to this (*Spirogyra*, fig. 10). In many cases also, where the chlorophyll is ultimately found in the form of distinct large granules, it appears at first like a mass of soft granular protoplasm, of a light green tint, from which the granular bodies are gradually formed. Thus in the cells just beneath the corky skin of potatoes (containing little or no starch), which have become green by exposure to light, the green colour is found first in the threads of viscid protoplasm which stretch out from the nucleus across the cell. In young cells of the leaf of a moss (*Hypnum*) the chlorophyll appears at first as a green

Fig. 10.



A. Portion of a filament of *Spirogyra*, with the green colouring matter in the form of broad bands (*a*), spirally arranged; in the bands lie groups of minute starch-granules (*b*), which appear as bright points, but are coloured blue by iodine.
B. A cell laid in syrup, in which exosmotic action has caused the colourless primordial utricle to contract, carrying the green bands with it, leaving the cell-walls free. Magnified 200 diameters.

irregular mass, which is subsequently organized into distinct granules.

It is very common to find chlorophyll granules described as consisting of a waxy or fatty substance, and chemists have generally very readily accepted this account, from the circumstance that the green colouring matter of leaves, &c., may be extracted by alcohol, and the substance thus obtained is of the nature just described. But this alcoholic extract yields a substance which is itself a compound, since a colourless waxy substance may be obtained from it, separately from the true colouring matter, which exists in very minute quantity. Not only is this green waxy matter a compound substance, but, what is of still more importance, it constitutes but a part of the constituents of the chlorophyll granules. When the green colour is extracted from chlorophyll, *in situ*, by the action of alcohol, under the microscope we find the granules left behind in their original position, only colourless (fig. 9, *c*). The green colouring matter may be observed at the same time upon the slider, at the evaporating edges of the alcohol, deposited in fat-like globules of very irregular size, some large from confluence while in solution.

A deeper investigation into the behaviour of the chlorophyll granules leads to a still more decisive refutation of the assumption that the chlorophyll granules are masses of coloured wax. When we open the cavities of cells so as to allow the escape of chlorophyll granules into the water, under the microscope, we find them swell by absorption of water, and a kind of endosmotic action is set up, bubble-like spaces often becoming hollowed in the interior (fig. 17, *b*), into which the water penetrates and "blows out" the granules. The edges of these swollen granules are found to be finely granular or minutely ragged. The bubble-formation through absorption of water is seen still more clearly in the green bands of *Spirogyra* above referred to, where it also reveals that the green colour resides only in the outer part of a colourless band of viscid substance, which is coagulated and contracted by the application of alcohol or most acids (fig. 10, B). When alcohol is applied to cells containing chlorophyll granules, for instance those of the grasses, the granules when decolorized mostly swell up at first, and subsequently become solidified, seemingly by coagulation. Tincture of iodine applied to the decolorized granules colours them deep brownish-yellow, the same colour which it imparts to the primordial utricle, the nucleus, and protoplasmic matters generally (fig. 9, *d*).

When the chlorophyll-bearing cells (for instance of a barley-leaf) filled with granules are digested in solution of caustic potash, the granules are at first swollen, then they gradually

coalesce into one mass, which contracts (apparently with the primordial utricle separated from the cell-wall closely investing it) and forms a finely-granular heap in the middle of the cell (fig. 9, *e*); this mass commonly exhibits a rather large central cavity filled with colourless liquid. The granular mass retains its bright green colour for several days; its granular appearance is chiefly dependent on exceedingly fine green points, probably minute globules of the green fatty colouring matter. The granular substance, with the green colour equably diffused, greatly resembles the green cell-contents of some microscopic Algæ, such as *Protococcus*.

When the cells are soaked in strong acetic acid, the form of the chlorophyll-granules is quickly lost, and they, together with all the rest of the cell-contents, coalesce into an olive-coloured liquid (?) substance, filling the entire cavity of the cell. In many cases this liquid exhibits numerous blackish molecules, probably separated globules of fatty substance (fig. 9, *f*).

The anatomical conditions, together with the reactions just detailed, which on the whole are the same as those exhibited by the colourless protoplasmic cell-contents of other cells,—making exclusion of the green substance soluble in alcohol,—lead to the conclusion that what is commonly described as chlorophyll is a somewhat complex and, to a certain extent, variable matter. It appears legitimate to assert that the basis of chlorophyll-granules, bands, &c., is formed by protoplasmic (albuminous) substances organized into definite forms, and in such a state of chemical composition that the action of light causes the formation, within their mass, but from without inwards, of a fatty matter associated with a green colouring principle. The fatty matter must exist in an intimately divided condition, and its presence in a kind of suspension probably causes the greater resistance of the outer than the inner part of the granules to the action of water, causing their expansion, vacuolation, and even bursting by endosmose of water. In a few cases the green-coloured fatty substance is developed at once in the ordinary protoplasm of the cell, in masses and streaks, or diffused uniformly throughout a granular mass filling the cells.

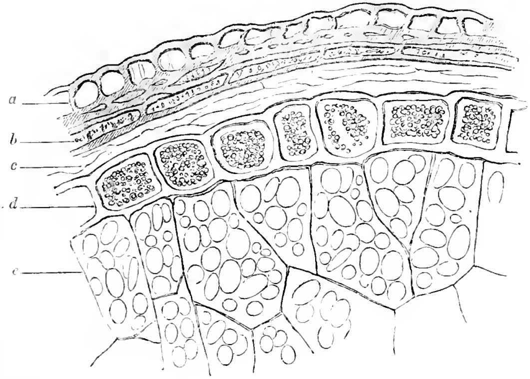
The green colouring principle may be separated from the fatty substance; it is present only in extremely small quantity, and its analysis shows that it contains nitrogen, which is absent from the fatty basis. Its origin and characters are still involved in great obscurity. This green matter of chlorophyll is closely connected with the colouring matters of autumn leaves, red cabbage, beet, &c., but this subject will be best dealt with separately hereafter.

The above-described conditions of chlorophyll present features of still greater interest when we consider them in connexion

with *starch*, since these two substances are very commonly present together, and several hypotheses referring to the evolution of oxygen by green organs have been based upon suppositions of convertibility of these substances one into the other. It will be most convenient to postpone the consideration of these questions until we have examined the characters and the developmental history of the starch-granules themselves.

Starch is at once one of the most important and most widely diffused of all the substances produced in the interior of vegetable cells. It is met with in all classes of plants except the Fungi, at some period of their growth, and in almost all tissues while in a young condition. It occurs, however, in greatest abundance in certain special tissues or organs, which on this account become of high value in an economical point of view. It is almost superfluous to say that we refer here to seeds, such as the cereal grains, &c. (fig. 11), tubers, like the potato and the analogous root-like subterraneous stems of the arrowroot plants. In the sago-plants it is accumulated in the parenchyma of the trunk, and even in ordinary trees it is found in considerable quantity in the winter season in the inner parts of the bark, the outer part of the wood, and in the pith in the neighbourhood of the winter-buds.

Fig. 11.



Section of the outermost part of the wheat-grain: *a*, the epidermis with a subjacent layer of cells almost obliterated by pressure; *b*, cells with thick and punctated walls; *a* and *b* are more or less coloured, *b* giving the brown colour of bran; *c*, a layer of clear colourless substance formed by the obliteration of several layers of cells through pressure; *d*, large thick wall-cells filled with finely granular protoplasm, without starch-granules; *e*, cells, with delicate membranous walls, filled with starch granules, forming the mass of the grain.

It is when thus collected in quantity that starch is of most consequence in the eyes of the agriculturist, but the physiologist is no less interested in its presence in smaller quantities in the cells of actively vegetating tissues, since it here evidently plays an important part in the general history of the nutrition of plants.

The characters of starch are best examined in some of those structures just referred to as containing it stored up in large quantities in their cells. If we place beneath the microscope thin sections of a potato-tuber, we perceive that its bulk is com-

Fig. 12.

Starch granules of the potato: *a*, various forms in the natural condition, the larger ones characteristic; *b*, a granule heated so as to cause a peeling-off of some of the concentric coats; *c*, granules swollen by heating in water; *d*, granules softened and "blown-out" by more violent action of hot water; *e*, granules in course of solution, from a growing tuber. Magnified 400 diameters.

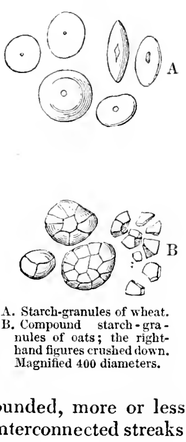
posed of membranous sacs or cells, containing a quantity of *granules* of very varied sizes, but of a form tolerably definite in all the larger examples. (See fig. 4, p. 75 of vol. xvii.) The smallest of these *starch-granules* are globular, the largest are more or less regularly egg-shaped, and intermediate forms are found in the intervening sizes (fig. 12*a*). In all but the smallest, concentric streaks may be observed, indicating a lamellated structure, the lamellæ being proportionately more numerous as the granules are larger (and older); this structure may be roughly

compared with the formation of the bulb of the hyacinth or onion, of coats successively enclosing the whole; the granule being transparent, the boundary lines of the successive layers or " shells " are seen through the whole thickness. The lamellæ are of very unequal thickness, and in the granules of the potato they are thickest at one side, or rather end, concentrically surrounding a minute point visible near the smaller end, which in the fresh granules is seen to be a minute cavity filled with liquid, and in dried starch appears to contain only air. Here and there in potato-starch are granules of medium or small size, and different form, with two or more of these central points or *foci*, each with a certain number of concentric layers, and then the outer layers running uninterruptedly round the whole as single coats, enclosing double or triple granules; this condition is far more common in some other plants.

The lamellæ are not only different in thickness from each other and in their own different parts, but the outer layers are of denser consistence than the inner; this may be shown by their action upon polarized light, but it is very evident also in their behaviour when solvent reagents are applied to the granules; another indication of it is afforded by the fact that in thoroughly dried starch the inner layers shrink, and radiating cracks are perceived in the interior, running out from the point-like cavity.

The starch occurring in the cells of the mealy structure of the corn-grains is essentially similar to that of the potato, but there are great differences of form of the granules, both from potato-starch and among different kinds of grain. The starch-cells of wheat are delicate membranous chambers (fig. 11, *e*), with closely adjoining flattened walls, and they contain numerous granules, of very unequal sizes, the larger of which exhibit the characteristic form for this plant, that of a flat doubly-convex lens; the point or cavity is central, varying in size, and concentric striæ are less easily distinguishable than in potato-starch (fig. 13, A). The starch of barley is in grains somewhat similar, but larger, the outline of the form being often rather squarish, and the sides more flattened, while the edges are thicker. The starch grains of rye are much like the foregoing. The larger of the starch grains of oats appear at first sight like irregular, rounded, more or less globular bodies, in which may be perceived interconnected streaks

Fig. 13.



A. Starch-granules of wheat.
B. Compound starch-granules of oats; the right-hand figures crushed down. Magnified 400 diameters.

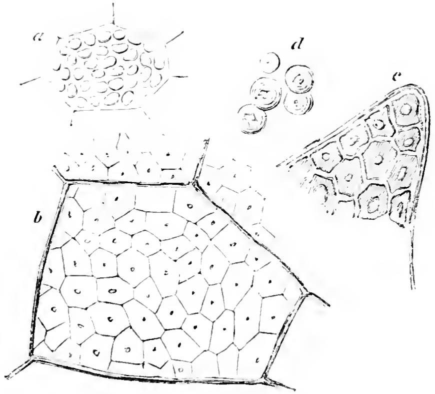
(fig. 13, B): when the granules are crushed down, it is recognised that these streaks are the lines of union of a number of irregular granules, each with its own "point" connected firmly together into a *compound granule.*

Starch is found in the seeds of beans and peas, in the form of roundish granules (fig. 2), with indistinct striation, and having the internal substance very soft, so that when they are dried the central cavity becomes comparatively very large, running out into wide cracks.

The starch of the rootstocks of the plants of the arrow-root and ginger families, yielding the various pure starches known by the names of "arrow-root" and "*tous-les-mois*," furnishes a number of round and highly-developed forms of the starch-granule. In *tous-les-mois* the granules are somewhat like those of a potato, but much larger and with more regular and delicate concentric streaks. The starch sold as arrow-root is derived from various plants, but the grains of genuine kinds are mostly recognizable, being very unlike those of potato, *tous-les-mois*, or the cereals.

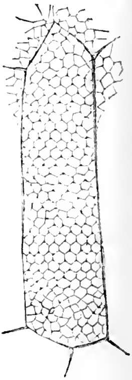
The starch of maize, at least in part, and that of rice, present peculiar conditions. In maize (fig. 14) the granules found loose in the inner cells of the seed are small and more or less rounded, but

Fig. 14.



Starch of maize: *a*, young cell with the nascent starch-granules imbedded in the formative protoplasm; *b*, full-grown cell with the perfect starch-granules densely packed; c, fragment of a similar cell treated with solution of iodine, which colours the starch-granules blue, and the intervening protoplasm brownish yellow; *d*, free starch-granules, from a cell where they are not compressed through crowding. All magnified 400 diameters.

Fig. 15.



Cell of rice-grain, showing the very numerous small starch-granules so densely packed that they form a solid horny mass. Magnified 400 diameters.

the outer cells of the seed are filled with starch-granules so densely packed that they are flattened against one another (*b*), and present angular forms, fitted together like stones in a wall; they all present rather a large central cavity. In rice (fig. 15), where the granules are exceedingly small, they are packed in the same way, but even more densely, whence arise the horny character of this seed, and the granular nature of its flour, in which the starch-granules are but imperfectly separated from each other.

The starch occurring more sparingly in the cells of vegetative tissues appears both in the *simple* and the *compound* form, the granules being usually far smaller than in the above-described examples—often so small that their nature can only be determined after causing them to swell up by applying certain reagents. The microscopist's universal test for starch, where the size or appearance of granules leaves their nature in doubt, is iodine, which colours the starch-granules a more or less deep violet or blue, according to the strength of the solution. Alcoholic tincture of iodine is often used; but this is apt to deposit crystals of iodine in the water in which the object lies, so that a solution of iodine in an aqueous solution of iodide of potassium is more convenient. When starch-granules have been previously treated with dilute sulphuric acid (which is done to swell them when very minute), the blue colour inclines to purple, more or less reddish, according to the amount of action of the acid. The nature of the combination of iodine and starch is yet unexplained by chemists, but the fact of the colouring produced is of the highest interest, not only on the ground of its value as a test, but from the relations indicated to the softer forms of cellulose above described. Starch-granules extracted from the potato, for instance, and viewed free in water, appear as solid bodies insoluble in cold water. They are found to contain a variable proportion of water in their substance according to the extent to which they are dried. The statement that they are not altered by cold water is only absolutely true of the external denser lamellæ, since we have found that, by crushing freshly-extracted granules, and allowing water to have direct access to the inner lamellæ, these occasionally swell out to some extent by absorption of water, and deform the grain, the outer lamellæ resisting the action. When the water is heated (and applying diluted sulphuric acid or solution of potash has the same effect), the granules swell, the streaks disappear, the internal substance softens into a jelly, and the whole swells up into a large gelatinous mass, having, however, still a definite outline. The phenomena here exhibited vary a little. Sometimes the softening and swelling are uniform; the whole granule is then as it were blown out into a gelatinous bubble, probably from endosmose of water, and the granule is thus

converted into a thin jelly-like sac, still insoluble in water. Very often the power of resistance is unequal at different parts of the structure, and the granule is first of all "blown out" out into one or more partial sacs or bulgings, which ultimately coalesce when the whole expands. This appearance may be produced by allowing sulphuric acid to run in upon the granules from one side of the slider. Still more frequently the granule bursts while swelling up into a sac (fig. 12, *d*), and then we not unfrequently find some of the internal substance extravasated in cloudy patches, which are rendered visible by applying iodine to the object.

When the starch granules of the potato (or *tous-les-mois*) are carefully heated on a dry slider of glass, and placed beneath the microscope, they present one of two appearances, the difference depending seemingly on their degree of dryness. They either split up, or rather *exfoliate*, the concentric coats cracking and peeling off one after another (fig. 12, *b*), or they become softened, lose the streaks, turn brownish, and swell into globules presenting a large central cavity formed by the expansion of the air contained in the original small point-like cavity (fig. 12, *c*). In both cases the starch has undergone decomposition as well as change of form; it has now become soluble in water, having been converted, in fact, into the gum-like substance called *dextrine*. The continued action of sulphuric acid, of boiling water, of substances producing fermentation, &c., likewise converts starch-granules into dextrine or sugar; and doubtless this conversion leads to the solution of the starch of seeds, &c., during germination. But in the processes of germination the solution of the granules takes place without a previous swelling up into starch-jelly, and the appearances vary in different plants.

When the starch of a well-sprouted seed-potato is examined, the large granules are found in various stages of diminution of size by superficial solution, by no means coincident with the concentric coats: the end containing the cavity persists longest (fig. 12, *e*). The compound granules of oats fall apart in germination, and are then dissolved from without inward. The grains of barley (as observed in malt) exhibit a different mode of solution; holes are formed in the outer coat, and the solution gradually eats out the contents, leaving a shell; singularly enough the same appearance occurs also in potato-starch when acted upon by fermenting yeast.

The mode of origin or development of the starch-granule has formed a subject of considerable debate among vegetable physiologists, but the principal facts may now be considered as ascertained. From the laminated character of large grains of starch, several observers were led to compare the starch-granule with

a cell having its wall coated with layers of thickening, and they explained the development as follows: the granules originated as vesicles, which by nutrition expanded and simultaneously formed a second coat *inside* the first, and so on, all the older expanding at each addition in the interior. This notion was supposed to be borne out by the fact of the inner lamellæ being softer and less resisting than the outer; but this circumstance admits of satisfactory explanation in another way.

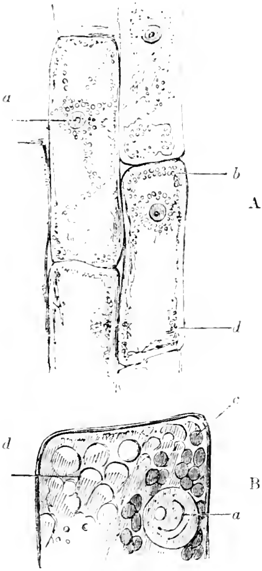
Starch-granules occurring in leaves and other actively-vegetating organs are almost always small, and scattered through the cell-contents. When the cells of such structures are carefully observed at the periods when the starch is in course of formation, the starch-granules will always be found in connexion with the protoplasmic or albuminous matters, sometimes in the nucleus, very often in the viscid strings of protoplasm running out from this, or imbedded in the layer lining the wall of the cell (fig. 16 B). Still more frequently, in green organs, are the starch-granules found in the *interior of chlorophyll granules:* to this point we shall return presently.

Observations made upon seeds, tubers, &c., in which the large, often highly laminated, granules occur, throw a greater light upon the subject: we there see that the connexion with the albuminous matters is a necessary one—that, in fact, the starch granules are formed through the agency of the protoplasm. It is found that the granules originate, in their earliest form of small round granules, in minute cavities which are produced in the substance of the protoplasm. Step by step in the larger forms the protoplasm deposits the layers which constitute the concentric coats, until the full size is attained. The excentric position of the minute cavity or point in potato-starch, *tous-les-mois*, &c., seems to arise from that end of the granule at which it lies being pushed out, as it were, from the general surface of the layer of protoplasm, thus hanging into the cavity of the cell, invested by a thin coat of protoplasm, by which it is less freely nourished than the other end. The compound granules, like those of oats, &c., are formed by a number of granules originating near together in the same mass of protoplasm, and, coming into contact, they become fitted together, and at last the intervening substance vanishes, so that they become firmly coherent. The double and triple granules sometimes found in the potato have the outer coats completely enclosing the whole, the external mass of protoplasm having deposited this after they had come completely into contact.

The formation of starch from the protoplasm is well seen in the grain of maize (fig. 14). At an early stage the starch cells are densely filled with protoplasm or albuminous matter. The

granules first appear in this as small globules, separate, and uniformly diffused through the protoplasm; solution of iodine colours them blue, while the matrix of nitrogenous matter turns yellow. By degrees, in the outer parts of the grain, the grains enlarge, until they come nearly into contact, and, to adjust them closely together, their original rounded form changes to polygonal, in which shape they appear densely packed in the ripe seed. On applying iodine to sections of the ripe seed, however, a thin stratum of yellow protoplasm is seen interposed between the adjacent grains.

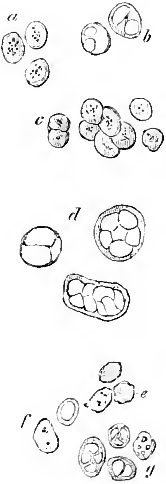
Fig. 16.



A. Cells from the stem of the white lily, containing nuclei (*a*) adherent to the protoplasm (*d*) lining the cell-wall, and, more or less connected with these, tracts of protoplasm, in which are forming chlorophyll and starch granules (*b*). Magnified 200 diameters.

B. Fragment of another cell magnified 800 diameters, after treatment with iodine: *a*, nucleus; *c*, starch granules imbedded in protoplasm (*d*), which in other parts exhibits "vacuoles," or water-bubbles.

Fig. 17.



Chlorophyll-granules, producing starch; *a*, young chlorophyll-granules; *b*, similar granules, with water-bubbles caused by endosmose; *c*, round chlorophyll-granules coherent in groups; *d*, the same in a more advanced stage, containing starch-granules, the chlorophyll forming a mere film over the surface (all the above from the young fruit of *Sphærocarpus terrestris*); *e*, *f*, *g*, chlorophyll granules from the prothallium of a Fern; *f* and *g*, older ones, in which starch-grannles are forming. All magnified 1000 diameters.

The presence of this formative protoplasm is evident in the starch-cells of the potato after they have been boiled. If a portion of the "floury" substance is placed under the microscope, it will be seen that the cells have become separated from each other, and that they are also swollen from the softening and expansion of the starch-granules. On the membranous walls of the cells will further be perceived reticulated lines, which are the coagulated remains of the protoplasm which intervened between the granules. With iodine these assume a yellow colour.

The connexion existing between the starch-granules and chlorophyll has already been noticed. Some of the more important features of their relations will now have become evident from what has been stated above respecting, on the one hand, the true nature of the chlorophyll, the fact especially of its having a basis of protoplasm or albuminous matter,—and, on the other, of the origin of starch-granules from a matrix of the same or similar material.

Chlorophyll-granules are found in all the vegetating organs of green plants, at some period of growth, having one or more small starch-granules in their interior. The size of the starch-granules, in comparison with that of the chlorophyll-granule containing them, varies extremely; sometimes the starch appears as one or more bright points in the substance (coloured blue when treated with iodine), sometimes the single starch-granule, or a confluent group of granules, appears surrounded by a mere film of chlorophyll (fig. 17). These differences of size are shown, by comparative observations on the same plant, to depend upon the age, that is, the degree of development, of the starch-granules; they grow up from an almost invisible point in the interior of the substance of the chlorophyll, just as free starch-granules do in the colourless protoplasm of seeds, tubers, &c. Chlorophyll-granules containing starch-granules are very well seen in many of the lower plants, as in the leaves of Mosses and Liverworts, especially in spring (fig. 17). Largish granules also occur imbedded in the bands of *Spirogyra* (fig. 10, A, *b*), and they occur abundantly during active vegetation in the green protoplasmic contents of the Confervoid Algæ generally. The closely-packed layer of chlorophyll in *Chara* has the granules sometimes so loaded with starch, that they form a dirty-blue layer when iodine is applied. In the higher plants the chlorophyll-granules of the deeper-seated tissues of green organs, as the middle substance of leaves, and the cells of the rind nearest the wood, present starch-granules more frequently than those in cells lying immediately beneath the epidermis.

It is observed that, generally speaking, the substance of chlorophyll-granules which contain starch is of denser consistence; it

does not absorb water so readily, and exhibit the "water-bubbles" above described. The application of water to chlorophyll-granules set free, only causes the line bounding the contained starch granule or granules to become better defined. The chlorophyll-granules containing starch usually acquire larger size than those in which it is not formed.

The starch-granules found in chlorophyll are by no means permanent deposits; they occur during very active vegetation, and vanish again (by solution?) in subsequent stages of development. They disappear in this way from the chlorophyll of leaves in autumn; but the phenomenon is especially well seen in the Confervoid Algæ, where the starch regularly disappears preparatory to the cell-division or the conversion of the green cell-contents into spores or reproductive cells.

The character of these corpuscles of chlorophyll containing starch-granules, has been interpreted in a different way; they have been regarded as starch-granules which have become encrusted by chlorophyll, the order of development having been assumed to run in the reverse direction from that just described. This has formed the basis for a chemical hypothesis of the origin of chlorophyll, which however fails not only on this ground, but also on its chemical basis, since it assumes at the same time that chlorophyll consists simply of the green-coloured fatty matter, leaving out of view the albuminous basis demonstrated by the experiments related in a preceding page. Mulder considered that fatty matter of chlorophyll was formed out of starch by a decomposition in which a quantity of oxygen was liberated. The process of conversion was supposed to extend inward from the surface to the interior of the pre-existing starch-granules. The origin of the green colouring substance (existing in very minute quantity), admitted to contain nitrogen, was not satisfactorily explained.

This hypothesis is in contradiction—first, to the essential nature of the solid basis of the chlorophyll-granules, a mass of protoplasmic or albuminous substance; secondly, to the observed history of development of the chlorophyll-granules which contain starch-granules; and, thirdly, to the fact, confirmatory of the evidence on the second ground, that chlorophyll-granules originate in cells of young organs wherein no trace of starch can be detected until afterwards. Still more striking are the cases of the green bands of *Spirogyra* and other Confervoid Algæ, which are never preceded by a starchy deposit of the same form.

Cases do indeed occur where chlorophyll-granules containing starch-granules increase in size, the starch-granules forming a "nucleus" for the chlorophyll; but that the starch affords the material for the production of the chlorophyll is in opposition to

the fact that most frequently the starch-granule does not contemporaneously diminish in size, but in fact often grows larger. Even in such peculiar cases as that of the potato-tuber "greened" by exposure to light, the circumstance that the chlorophyll of the outer layers of cells, which contain little or no starch, is formed in the protoplasmic substance, warrants the supposition that in the more deeply-seated starch-cells those starch-granules which become coated with a layer of chlorophyll received this as a deposit from the protoplasmic substance which we know to exist diffused through the cell, and that the starch-granules are probably dissolved and diffused in the cell-sap before being utilised for new developments.

The evidence, then, furnished by the history of development of chlorophyll- and starch- granules, leads us to conclude that the relation of starch to chlorophyll is chiefly, if not entirely, dependent on the fundamental identity of the albuminous substance, forming the material basis of the chlorophyll-granules, with the protoplasm or nitrogenous formative matter of the cell.

The matters belonging to the cell-contents, which have up to this point been examined, are at once substances very generally when not universally diffused in the vegetable kingdom (the Fungi affording the exception as regards chlorophyll and starch), and at the same time accessible to microscopic investigation. Various other products remain to be enumerated, to which those characteristics only apply partially, or are even inapplicable.

Fatty matters or fixed oils may be regarded as very generally present in plants, and they occur for the most part in conditions analogous to those in which starch is found; indeed, fixed oil is not unfrequently found replacing previously existing starch-granules in the very same cells, possibly through a transformation. Oils are often to be detected, by the microscope, by their standing suspended in drops of variable size in the cell-sap. If abundant, the drops are often large, and their nature may be determined not merely by their optical characters, but by their confluence under pressure and their solubility in ether (fig. 4, *e*). In living cells they are never in immediate contact with the cell-membrane, but lie inside the albuminous lining of the cell, and adherent to the masses of protoplasm. In many cases where the oil is in small quantity it is so intimately combined with albuminous substance that it cannot be detected by simple inspection under the microscope; but heating the cells, so as to solidify the albuminous matters, often causes the separation of the oil in drops. Drying up oil-bearing cells will likewise cause confluence of the drops, and, when the albuminous lining of the cell is destroyed or injured, the oil readily soaks out through the cell-

membrane, as is observed in old seeds which have become "greasy."

Examples of cells containing fixed oils are afforded by many well-known seeds, such as linseed (fig. 4), seeds of poppies, cotton, castor-oil, many palms, &c., in the "endosperm" or substance formed to nourish the embryo; and in rape, nuts, almonds, &c., in the cotyledons of the embryo itself. It is a point deserving especial remark, that starch occurs in these same structures before they are completely developed, and vanishes subsequently. We observe in the lower Algæ, again, that the starch of the vegetative cells is replaced by drops of oil in what are called the "resting-spores,"—the reproductive cells capable of bearing drought or winter-cold without losing their vitality, which in these plants represent the seeds of the Flowering plants.

Comparatively little is known at present regarding the production of these fatty matters; undoubtedly they are nearly related in their origin to starch, from which they differ in composition chiefly in the diminution of the proportion of oxygen. A certain proportion of oily matter occurs very generally in structures abounding in starch, such as potatoes, or with starch and "soft" cellulose, as in beans and pease, where it is apparently suspended in the albuminous protoplasm. Possibly a portion of the fat given in analyses of the green parts of plants, as of grass (and dried as hay), may be derived from the chlorophyll.

Dextrine and *sugar* are substances of universal occurrence in plants, but, being excessively soluble, they are generally found only as constituents of the watery cell-sap, invisible to the microscopist, and only to be discovered by ordinary chemical examination of the juices; yet they are really among the most important of the products of the cell; and their formation and their transformations, in company with starch, cellulose, and the other substances devoid of nitrogen, constitute some of the principal operations of healthy vegetation.

We have seen above that starch-granules are converted into dextrine by heat, sulphuric acid, and other agents. This conversion occurs in the cells of starchy seeds in germination, as is seen in malted barley. Since, therefore, we find dextrine in the expressed juices of the organs of plants which are in a state of active vegetation or development, while it is replaced in a great measure by starch, cellulose, or fixed oils in resting organs, we cannot avoid the conclusion that dextrine constitutes one of the transitory, soluble forms of the neutral ternary series of compounds (cellulose, starch, &c.) holding the assimilated food in a condition in which it is directly applicable for organisation through the medium of the albuminous formative matter.

The various sugars—grape-sugar, cane-sugar, &c.—stand in

much the same position as dextrine in reference to development; they occur in similar situations dissolved in the watery cell-sap, abounding often in young shoots, succulent stems, &c., especially at the epoch just previous to flowering. Sugar is formed in company with or probably from dextrine, out of the starch of germinating tubers and seeds; so that it is not merely a product of simple assimilation, but, like dextrine, also a soluble material capable of being derived from decomposition of more highly elaborated matter (starch and cellulose) where this is required for new development.

We have spoken of dextrine and sugar as dissolved constituents of the watery cell-sap, and this is their general condition. When sugar is very abundantly formed, it is sometimes deposited in crystals, forming a kind of excretion, as is observed in parts (nectaries) of various flowers. This phenomenon, however, is of minor importance physiologically speaking, and is of far less interest than the occurrence of solid gummy matters, approaching very closely in character to dextrine, and at the same time distinctly related to cellulose. Gum arabic, the gum of plum and cherry trees, are exudations from the stems of trees, ordinarily regarded as excretions resulting mostly from disease. They are supposed to be derived from the watery cell-sap; but this is very doubtful, for it has been shown that gum tragacanth, which exudes from various species of *Astragalus*, is essentially analogous in its nature to those semi-gelatinous thickening layers of the cells of seeds described in an earlier page, only that the approach is here to dextrine and not to starch. In the tragacanth-plants the parenchymatous cells of the pith and the medullary rays have their walls greatly thickened as they grow old with the "soft" cellulose compound, which in time loses to a great extent its laminated character, and, undergoing a chemical modification, becomes almost homogeneous, acquiring at the same time the property of swelling up strongly when placed in water; so that the access of wet to the stems causes these cells to swell up, burst, and exude in a gummy mass upon the surface of the bark. The gummy matter obtained from quince-seeds and linseed consists in like manner of the soft thickening layers of cells, that is of cellulose approaching in physical condition to dextrine, retaining its structure (fig. 4) until a late stage of its existence, but passing chemically into a condition in which sulphuric acid and iodine do not readily produce a blue colour. In tragacanth gum treated with those reagents, fragments of cell-structure are revealed in the gelatinized mass; the mucilage layers of quince seeds turn blue with a more active iodized preparation (iodide of zinc). The slimy substance of the Confervoid Algæ, and the gelatinous tissue of the larger sea-weeds, appear to consist of a

similar substance, *i. e.* cellulose metamorphosed structurally and chemically into a homogeneous substance intermediate between cellulose and dextrine, insoluble in water, but naturally containing a great quantity, and passing into a horny condition if dried.

Inulin and *pectin* are products which have been described and studied by chemists, and their relations with starch and the soluble ternary compounds seem very close. The microscope is, however, of little avail in the investigation of these substances, since they present no definite structure as they exist in nature. Inulin is extracted from the tubers and tuberous roots of various plants of the botanical order Compositæ, such as that of the Jerusalem artichoke (*Helianthus tuberosus*), the root of elecampane, the dahlia, &c. It is obtained separate by extraction with boiling water, which in cooling deposits a structureless granular substance, which is not coloured blue by iodine. Its composition is the same as that of cellulose, and it is very readily converted into sugar; hence it would appear to be a substitute for starch and dextrine peculiar to certain plants.

Pectin is obtained as a gelatinous matter from various fruits, such as apples, pears, &c., and from roots, such as the turnip and carrot, by boiling, and its occurrence in large quantities in the economical plants imparts to it a high claim to the attention of physiologists. Unfortunately the chemical part of its history still presents a somewhat complicated and uncertain collection of results, which are incapable of being brought into relation with the other facts of the nutrition of plants. The analysis of pectin shows that it differs from the starch and cellulose series in not containing oxygen and hydrogen in the proportions of water. It is found in ripe fruits, with sugar, where vegetable acids have been previously abundant, and it is said to be produced from unripe fruits by boiling with sulphuric or malic or tartaric acids. Now as the cell-walls of the succulent tissues of fruit are somewhat hard and resisting before ripening, and afterwards become very delicately membranous, the substance (outer lamellæ of the cell-wall?) originally cementing them together dissolving away, pectin would appear to be derived from the action of acids upon cellulose; hence it approaches in its mode of origin to dextrine, but the chemical composition opposes an obstacle to any further comparison between them. The investigation of the subject of pectin, especially in connexion with the growth of turnips and mangel wurzel, is one of the pressing desiderata of agricultural science.

The further constituents of the watery cell-sap are to be regarded as rather special than general, for such of them as occur indiscriminately in all parts of plants are rather unassimilated products carried forward in the diffusion of the sap than proper

cell-contents. Among these are the dissolved gases, carbonic acid, oxygen, &c., mineral salts, salts of ammonia, &c. The compounds of mineral bases with organic acids form a special class of products, some of them occurring probably in most of the higher plants in particular stages of growth. Their presence has been chiefly noticed, and their relations to vegetative life examined, in the cases where they exist in especial abundance, in soluble (malates, nitrates, oxalates, &c.) or insoluble (oxalate of lime) conditions. The oxalate of lime occurs in great quantity in a crystalline form in certain plants. The study of these compounds in reference to vegetable life lies at present wholly in the province of the chemist.

The colouring matters of plants (exclusive of chlorophyll) are at present very imperfectly known as regards their chemical relations to each other and to the other substances met with in cells. Their mode of origin is, anatomically, similar to that of the watery cell-sap in colourless cells, as described in a former page (388), with the difference, that in the excavations or "vacuoles" formed in the viscid protoplasm is produced a coloured watery fluid, usually clear and transparent. As the young colour-cell expands, the separate accumulations coalesce in the central cavity of the cell; but the entire collection is enclosed by the albuminous layer lining the cellulose wall, through which it never passes, although a watery juice, during the life of the cell. We may very often observe two adjacent cells with watery fluids of different colours, which, in the natural state, do not intermix, although separated but by the delicate cell-walls. When such cells are placed in a solution contracting the primordial utricle, the latter shrinks up a little, and then mostly bursts and emits the coloured watery fluid which exudes through the cellulose membrane. Not unfrequently granular bodies occur in the watery fluids of colour-cells; these have not been properly examined.

The colour-cells of petals and other organs of flowers lie in one or more layers immediately subjacent to the epidermal layer of cells. The peculiar colours of the leaves of certain plants—as of red-cabbage, beet, &c.—arise from the sub-epidermal layer of cells being filled with a colouring fluid, like that of petals, instead of containing chlorophyll as usual. The chlorophyll of these plants lies in the deep middle region of the leaves, and is screened by the interposed red cells, to which it imparts a bluish or greenish tint. In the red cabbage the ribs and veins of the leaves have brighter red tints because there is no subjacent chlorophyll in those parts, which are white in the green cabbage. The red and the distinct yellow and orange hues which many green leaves assume in autumn, owe their tints, in the first in-

stance, to the formation of a coloured watery liquid in the same sub-epidermal cells which contain the colour of red-cabbage leaves; but very often, as in the Virginia-creeper, the alteration gradually affects the cells all through the leaf. The tinted liquid appears to be formed at the expense of the remains of the chlorophyll-granules, since these are found in small number in cells in process of change, gradually losing their colour, and then vanishing, until the cell is filled with a coloured fluid, which may be extracted either by water or alcohol, but most readily by the latter. So far as we could ascertain the point, the albuminous lining of cell ultimately disappears here, leaving the coloured liquid in direct contact with the cellulose membrane. The brown colour which the fallen leaves subsequently assume, and which many leaves acquire in the first instance, without displaying red or yellow tints, arises from the transformation of the cell-membranes into humus, the first step of their decay into vegetable mould.

The leaves of other trees turn almost white when they are about to fall. This depends upon their cells assuming a condition similar to that which is constant in the white patches of "variegated" leaves. The chlorophyll and other contents vanish, leaving scarcely anything but the empty cell-membrane behind. The white patches and spots of variegated leaves are well known to depend on the absence of chlorophyll in the subjacent parenchyma, and they therefore constitute a disease. The common *Aucuba*, or "spotted-laurel" of our shrubberies, is a diseased plant of this kind, having perfectly green leaves in Japan. The disease is hereditary here because it is always grown from layers, and not by seed.

The colouring-matters of fruits are similar to those of autumn leaves in regard to their replacing chlorophyll previously existing in the same cells; but we observe here greater variety of colouring, resembling what occurs in the coloured organs of flowers.

The subject of the colouring matters producible from vegetable structures, such as indigo, madder, &c., is beyond the scope of the present paper, but, when further investigated, will probably throw much light upon the chemistry of vegetation.

The aromatic or essential oils which are found more or less abundantly in a great variety of plants are mostly formed in special cells, occurring singly or grouped into the so-called "glands," in connexion with the epidermal structures. The cells containing these oils are, when fully developed, filled with the secretion, which is separated from the cellulose wall by a thin layer of protoplasm (primordial utricle). When observed in younger stages it is perceived that the oil-cells are originally

filled with the protoplasm or albuminous substance, and that the oil is excreted in drops into hollows formed in this. As the oil-drops increase, and the protoplasm is absorbed or consumed, the drops coalesce, until at length they displace all the protoplasm except the layer lining the wall of the cell. The conditions are analogous to those above described of the cells containing watery fluid colouring matters; and it is through the agency of the thin layer of albuminous matter that the oil is prevented from exuding through the cell-wall in the living cell. When this pellicle is disorganised the oil soaks readily through the cellulose-membrane. Most of these aromatic oils consist of a mixture of an oil liquid at common temperatures with a substance analogous to camphor or stearoptene, solid at common temperatures when separate. Stearoptenes are found alone, generally in a crystalline form, in the wood of various aromatic trees; but their developmental history, as well as that of the various resins, is still involved in obscurity.

The so-called "milky juices," such as abound in the roots of lettuces, dandelions, the stem and foliage of poppies, spurges, &c., exist in special tubular reservoirs, which appear to be intercellular passages into which the secretion has exuded; some authors, however, believe these canals to be formed by the confluence of rows of cells. The juices are not "milky" until exposed to the air; they consist of clear fluid containing dissolved albuminous matters, with globules of resin and sometimes starch-granules in suspension; the milkiness disappears again when they dry up, and there remains a resinous substance, varying in consistence and composition in different plants—often, as in the case of the opium-poppy, the lettuce, &c., containing the active principles to which the plants owe their economic or medicinal value.

Nothing general can be stated at present regarding the production of these juices, which, however, deserve careful investigation, since they exist in small quantities in a great variety of plants, and give the special value to a number of species or genera useful to man. These juices are interesting to the physiologist, moreover, like the volatile oils, on account of their important connexion with those chemical processes in which oxygen is liberated, since they are either hydro-carbons or poor in oxygen, and their abundance in a given plant stands in relation to the amount of exposure to solar influence. This relation is not confined to the oily or resinous matters, but holds good of the active principles (alkaloids, &c.) mixed with them. The class of Conifers (pines, firs, &c.) appears to form an exception to this relation of resinous secretions to the sun's action, since they belong especially to high latitudes and mountains; possibly their

persistent evergreen foliage may have some influence in producing the abundance of highly-carbonised secretion.

It is now time to look back over the particulars which have been expounded in the foregoing pages, in order to see how far we are enabled to draw from them any general physiological conclusions. One thing strikes us at first sight—the absolute necessity of entering upon the examination of the phenomena in their microscopic detail,—since we have found that even the simply chemical, like the vital, processes take place in what we have termed the organic or physiological "atoms," the cells. Each of these is a little apparatus in itself, executing its special duties in more or less close association with its fellows, and the physiological functions of the plant represent the sum of the diverse actions of a multitude of these, which we have seen to be more and more limited to special or individual operations in proportion to the variety existing in their organisation and arrangement. For this reason it is requisite to devote the greatest attention to these *minutiæ* of the appearances and changes in the contents of cells, which have been described at some length in the present paper. Only through an intimate knowledge of the phenomena presented in the actively vegetating cells, can we hope to arrive at a clear comprehension of the essential facts, and the general laws of the nutrition of plants.

The accounts of the mode of development of cells given in our former paper (vol. xvii. p. 62), and of the formation of the various products of the cell described in the preceding pages, demonstrate the extreme importance to vegetable life of those principles commonly called "albuminous," characterized by a definite composition into which nitrogen enters. These, which the chemist distinguishes into albumen, fibrine, legumine, &c., the microscopist recognises, under the name of *protoplasm*, as the seat of the vital activity of the plant, whether evinced in growth or in the assimilation of nutrient substances. On a former occasion we found them reproducing the cells themselves; in the present paper it has been shown that not only is the cell-membrane produced by their agency, but that they form the basis of the chlorophyll-granules, produce starch, oils, colouring matters, and apparently also the soluble matters of the watery cell-sap. And not only do they produce all these things, but they have the power of decomposing and reconstructing almost all of them, as may be required by the local or temporary exigencies of the plant, so that they form a sort of centre or medium with which all the processes of vegetation are more or less directly connected.

We may venture to suppose, therefore, that the ternary substances, the cellulose and starch, &c., series, are produced through

the agency of the nitrogenous principles; that the latter consequently are the primary substances in vegetable assimilation. The question then arises, How and where are these nitrogenous principles produced? From the presence of the protoplasmic matter abundantly in rootlets, from its existence in quantity in Fungi and in other plants grown without access of light, we are led to think favourably of Mulder's opinion that these matters may be formed directly in the roots of plants; the recent experiments of Boussingault, of growing plants in sand, with only mineral substances, where the use of nitrate of soda caused a production of nitrogenous principles equal to what would have been obtained in a fertile soil, seem to show that as a rule the nitrogenous substances are taken up by the roots, and the *protoplasm* may be produced there from nitrates or ammoniacal compounds.

The further question then presents itself, How do the ternary compounds originate? Judging from anatomical investigation, we may answer, from the albuminous substances, but in what manner, and where, we are not prepared to say. The hesitation with regard to these points arises from the changeable and ubiquitous characters of these ternary principles. Yet we have some data. There is certainly strong negative evidence afforded in the inability of Fungi, colourless parasites, and etiolated plants, to produce any considerable development of cellulose in their texture, or, as regards the Fungi, of starch-granules in their cells. Nitrogenous substance is found abundantly in these cases, but the cellulose products are weak and perishable. If the protoplasm had the power of assimilating carbonic acid and water without the peculiar solar action which causes the green colour of chlorophyll, we do not see why there should not be abundance of cellulose, &c., in those cases where nitrogenous matter abounds. There is reason to think that organic compounds are taken up in these instances to afford material for the production of the cellulose; and this seems to be borne out by the influence of humous substances in the manure applied to turnips. But ordinary plants do not form their due quantity of cellulose, starch, &c., unless they receive the influence of light, causing a green coloration of their foliage.

Our attention is thus directed to the chorophyll granules, as the agents of assimilation of the ternary substances; those granules formed of "protoplasm," which, under the influence of light, become impregnated with a waxy matter containing a green colouring principle. We know that this matter is produced in proportion to the amount of solar action, *provided a sufficient supply of nitrogenous matter is afforded to the roots;* further, that the quantities of ligneous cellulose, starch, oil, and the more highly carbonized essences, resins, &c., are all similarly pro-

portionate to the formation of chlorophyll. But we are arrested here. A multitude of questions at once crowd upon us, to which we cannot give any answer. Does the assimilation take place in the formation of the waxy matter? What is the import of the green colouring principle? Is all the assimilated matter first combined in the chlorophyll-granules, and then decomposed in the dark into dextrine, &c.? Or do the granules work by "contact-action," whatever that may really signify? Further, does the soluble assimilated matter, which may exist as dextrine and sugar, when formed by direct assimilation, or by decomposition from starch, fixed oils, or soluble cellulose (amyloid), merely mix with, or enter into combination with the albuminous substances, which use it for reconstruction in other situations? That it enters into mixture at least is evident by the way in which cellulose, starch, &c., are formed upon its free surfaces by a kind of excretion; there is no contact-action upon a surrounding medium when starch-granules are formed in cavities of the substance of the albuminous matters, any more than when watery-cell-sap, containing dextrine or sugar, is exuded into newly formed vacuoles: still less when a cellulose membrane appears suddenly upon the surface of the free mass of protoplasm, lying in water, as in the germination of the zoospores of the lower Algæ. Through what means and with what changes of their own constitution the nitrogenous matters are enabled to take up and lay down, as we may express it, the so-varied secondary products of assimilation, are questions of extreme complexity, altogether obscure at present; and they present remarkable difficulties in the way of investigation. So much knowledge, however, has been attained in recent times in the domain of organic chemistry, that every encouragement is offered to the prosecution of these inquiries. In the mean time there is abundant work for the microscope in investigating the special cases of cultivated plants in their varied conditions and stages of growth. This alone can furnish a key for the explanation of the different composition of structures in different stages, revealed by chemical analyses, since it is evident that the diversity depends upon the operations which have their seat at a given epoch in the cells of a given tissue, not in accidental differences of a general "sap" passing through the organs.

Through the joint efforts of the chemist and the anatomist, with a more extended use of the experimental method, we may hope to arrive in time at the true theory of vegetable nutrition, and to solve also the problem of the "circulation" or "diffusion" of sap in plants.

XVI.—*Report on the Exhibition and Trial of Implements at the Salisbury Meeting.* By C. Wren Hoskyns.

The steady annual increase in the number of implements exhibited at the country meetings of our Society, especially since Steam-machinery has happily formed so large and important a class, had begun not only to multiply but very materially to change the duties, and the attending responsibilities, of those to whom the Society committed, year after year, the necessary arrangement of the trials; when the proposal submitted to the Council by the principal manufacturing firms, viz. that the *Trial* of implements should take place only once in three years (reducing the two intervening meetings to mere exhibitions), was met by a counter-resolution from the Society, the adoption of which has led to the most useful results.

We owe to the late Mr. Pusey the classified arrangement—following what may be called the "natural order" in agriculture—which formed the basis of this resolution, and now governs the implement trials at the Society's country meetings, the system being that of a threefold *division* of implements and machinery, arranged in the order of their use: 1. In the preparation of the *soil;* 2. In the treatment of the *crop*, from sowing to gathering; and 3. In the conversion of the *produce*, and barnwork.

This triple division, favouring, in the accidental identity of *number*, the proposal which indirectly led to it, by occasioning, in fact, a triennial trial in *each* of the respective classes above named, commenced its course in 1856 at the Chelmsford meeting, and reached its second year, viz. that of the trials of implements applied to the crop, at Salisbury, where it, of course, included the Reaping-machines, leaving the steam-ploughing as the only exception (made for obvious public reasons) to the plan, which, independently of its merit as a systematised arrangement, has brought timely relief to a rapidly-increasing pressure on the stewards and judges, likely to have proved injurious, in tendency, to the value of the trials themselves.

There is, however, undoubtedly, one disadvantage which still applies to this as to every other mode of carrying out such trials: that, whereas the use of agricultural implements belongs to *all* the seasons in succession, an annual trial can take place only at *one;* and as this will of necessity be that in which farm business is most at leisure, it is of course likely to be the one most generally unsuitable for the use, and consequently for the accurate trial, of any. The reaping-machines must be launched upon a half-green rye crop, generally, for some unexplained reason, very thin, and very foul, to prove their capacity for cutting a field of strong ripe wheat, a trial sufficient, perhaps, for general, but inadequate

for comparative judgment; the drills must be content to prove in soil caked or powdered by the evaporating rays of a July sun how they would open and close the channel for delivery of the seed in a stiff soil in November; the ploughs, both horse and steam, must be ready at word of command to dash their shares and coulters upon a forlorn hope of "steel *versus* flint," seven inches under the hardened surface of a two years' ley. Whatever, in fact, the appropriate season or necessary conditions for an instrument's use, it must meet the peremptory assize and take its trial, timely or untimely, and the judges must form the best judgment they can upon a case that cannot be deferred, under the indifferent satisfaction of knowing that the disadvantage, though in appearance general, is in reality unequal.

Still, the experience gathered year after year by the judges themselves tends, more than would be readily imagined, to mitigate this inconvenience, and it is not too much to say, after a four years' witness of the performance of their duties by the gentlemen whose names are appended to the following Reports, that a more liberal and judicious exercise of the care and pains, as well as skill, required for accurate judgment in their often most difficult tasks could hardly be exhibited.

The triple classification above referred to has obviated the growing inconvenience of their attention being divided among too many objects wholly different and requiring different modes and places of experiment; and at the Salisbury meeting the benefits of a more concentrated attention, and examination of every implement placed under working inspection, were most strikingly shown.*

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* Those who read with pleasure Reports of Agricultural Meetings will find no small interest in the following descriptive portrait of an American Agricultural Show-yard on a truly gigantic scale, held in the State of Missouri, U. S. It is extracted from a letter written by the Hon. M. B. Portman. Even if it did not, as I think, contain some very useful suggestions, worth consideration on *this* side of the Atlantic, I could hardly resist the opportune insertion of so lively and characteristic a 'Report' amongst those which I have the pleasure to place before the Society.

C. W. H.

Extract of Letter, &c.

St. Louis, Missouri, Oct. 2nd, 1857.

Now I will tell you all about the Agricultural Exhibition and Fair. All Missouri is now here, and everybody is out at the Exhibition Ground: *forty-seven thousand people* on the ground at

With the exception of a few slight showers during one night, the weather throughout the whole period of the trials was without a cloud, except, indeed, of dust; and a scene more striking can hardly be imagined than that which presented itself to the spectator from a hill which, rising abruptly from the town, in the direction of Old Sarum, divided the show-yard, which lay immediately under it on one side, from the principal trial-fields of drills and other implements on the other. It was upon this elevated spot, accessible only from a narrow road by a still narrower turning, very steep, and partly over soft fresh-cultivated ground, that the steam-ploughing was to come off, if, at least, it could ever come on. The temptation of an unenclosed space of eight-

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once. The whole is admirably conducted; there are 50 acres of ground, with stalls all round the enclosed space; and in the middle of the 50 acres there is an amphitheatre for showing the animals in, 250 yards in diameter, surrounded by covered seats for about 40,000 people! it reminded me of the Bull-ring at Mexico. The ground was bought by this city for this express purpose, and all the buildings are permanent.

I was much fêted (perhaps in return for your civility to the deputation from the United States at your Salisbury Meeting), introduced to everybody, got a seat with the Judges, &c. &c. In two instances, sitting in the ring, I was able to pick out the winners of the prizes for cattle before the award was made. The show of animals is very good; no great numbers, but splendid beasts: I never saw finer cattle than the three prize animals. The horse-show is also very good; the horses magnificent; all trotters; as many as 36 trotting-horses in harness at the same time, racing in the ring. I never saw finer trotters anywhere. The French Canadian horses are the great favourites here, as they are considered so hardy. The show of mules was excellent; pigs capital; sheep less good; poultry show very good; machinery, I suppose, the best in the world; all the implements of the very best kind, for *this* country, at any rate. I think the plan of all the animals being judged publicly in the ring a very good one; as public opinion is loud in condemning the favouritism so often shown by so-called judges. Kentucky carried the prize for fat cattle: this State (Missouri) was first for mules, won several prizes for horses, and was second for cattle. Everybody is very busy at this Fair and Exhibition, which lasts a whole week. There are, however, no great dinners and speechifying, as you have in England, for the time of everybody is engrossed with business. My friends tell me I could not possibly have come to buy land in any place where I should be so likely to do so to advantage in every respect as in this State.

M. B. P.

and-thirty acres for these trials can hardly be called with propriety the inducement to the Society to accept the offer of such a spot, because there was no other choice; but it is to be hoped that, in all future negotiations with the towns or localities at which the summer meetings shall be held, the very ample area required for this class of trials will be regarded as a *preliminary condition.* Something of the same kind of difficulty, coupled, however, with the opposite disadvantage of soaking weather, occurred at Carlisle, where Mr. Usher's steam-plough failed to obtain a field-trial from inability to make its way from the show-yard, which the rule of the Society requires to be the head-quarters of every implement, whether for trial or exhibition.

It is quite true, as the judges remark in their Report, that a steam-plough ought to be able to convey itself from the farm-steading to the field; but it unfortunately happens that a show-yard improvised in the immediate environs of a large town is as much the opposite as can well be conceived in all its incidentals, of a farmsteading, which (inconvenient as their position often is) is yet the recognised point to which the roads of the farm converge. The narrow zigzag of two acute angles, only a few yards from each other, which formed the only road to fame in steam-ploughing at Salisbury, afforded, indeed, a striking opportunity for exhibiting the admirable docility and power of Mr. Boydell's traction-engine, which reached the trial-ground in ten minutes from the yard; but the same acclivity which compelled Mr. Fowler to throw himself on the resources of the Society to draw up his ponderous second engine, boiler-full, and not steaming, with eight of their most powerful horses, and which broke the breastplate of Mr. Collinson Hall's engine at the *second* angle of the zigzag, after successfully passing the first, formed a sort of preliminary struggle neither necessary nor desirable as an introduction to the sufficiently arduous experiments in steam-ploughing. Still the judges and stewards had no choice in the matter, and it is only to be hoped that they may never be called upon to exercise their duties under like circumstances again. To the important subject of the trial itself further reference will be made in the order in which the Reports of the judges are arranged, following as nearly as I have been able the same plan, subordinately, as that which now governs the triennial division.

The trials of Drills were of a most laborious, not to say tedious, character, outlasting, from their great number and minute shades of variety, all the other trials; and too much credit can hardly be given to the indefatigable perseverance of the judges in this branch, Mr. Caldwell and Mr. Druce jun. It seems to mark a stage advanced far on the road to perfection when anything new in the construction of an implement has begun to gene-

rate a feeling, in the mind of a really experienced judge, more akin to fear than to hope. Strange indeed would have been the apparition of one of those highly-finished and complicated-looking instruments to the eye of the great Experimentalist, whose homely description of his first idea of an invention now so elaborately matured, they bring to mind with all the force of contrast. "To that purpose" (the securing himself from the *intentioned* irregularity of hand-sowing by his men) "I examined and compared all the mechanical ideas that ever had entered my imagination, and at last pitched upon the groove, tongue, and spring in the sound-board of an organ. With these a little altered, and some parts of two other instruments" (what were they?) "added to them, as foreign to the field as an organ is, I composed my machine. It *was named* a DRILL, because, when farmers sowed their *beans* and *pease* into channels and furrows *by hand*, they called *that action*" (in allusion to military order) "drilling." So that, after all, the deaf old gentleman who repaid an exhausting explanation of the virtues of the "last new and improved" implement in this class with the exclamation, "Very ingenious, very!—and, pray, how many *tunes does it play?*" would have astonished Jethro Tull, the inventor, considerably less than Mr. Hornsby the improver. The well-conceived substitution of caoutchouc instead of tin pipes, by Mr. Hornsby, has added an improvement that will be appreciated by all lovers of harmony, whether of sound or action. There is still room for a very saleable implement in this class on a scale smaller than that called the 'small-occupation drill.' That it would not be a really economical implement is true, but it would not on this account be less appropriate, since the class of holdings to which it would apply is not susceptible of the highest economy in implements, as in other respects.

The dry-manure Distributors furnished one of the most interesting trials of the whole meeting. Whoever has witnessed the effect of hand-sowing guano on a dry windy March day will not refuse the epithet *humane* as well as economical to these inventions. Chambers, Holmes, and Reeves, at the descending scale of 20 guineas, 14*l*., and 10*l*., are the names and the corresponding prices that offer themselves; that of Messrs. Reeves, at the lowest sum, being introduced first to the Society at this meeting. The machinery of the two dearer ones is most ingenious, and almost inevitably exact in their low, equable, and steady delivery of the manure, whether damp or powdery. But Messrs. Reeves's lower-priced instrument, which seems as effective as it is simple, is a positive boon to the *labourer* as well as the farmer; for, in a matter of this kind, a low price decides a question which hangs in conflict in many minds—"to buy or not to buy,"—virtually stopping the

good deed by suspending it *sine die*. It has occurred to me in the course of watching the trials, and in using one of these implements, that a good deal of time and trouble might be saved in the pounding and even mixing of what are, or have hitherto been, called "hand-manures," if distributors were furnished with a wire drum of the squirrel-cage or "turnspit" pattern, which (reaching from wheel to wheel) might revolve in a semicircular wooden trough, instead of that now used, and riddle out the contents, discharging at intervals, for pounding, the lumpy and hardened portions of the manure which alone require it, instead of, as now, submitting unnecessarily the *whole* mass, both fine and coarse, to the same process. The *mixing* action would have every likelihood of success, as it would be performed, in fact, by a process very similar to that used in several trades where mixing is required, as by tea-merchants, grocers, and others.

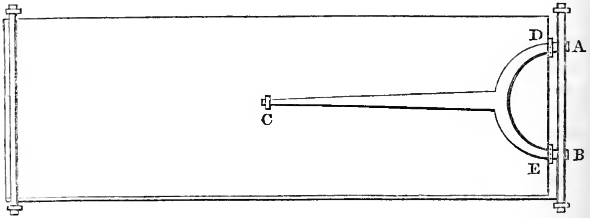
The true test of merit is the thoroughly equable distribution of a *small* quantity, two or three bushels, for instance, of valuable manure over a given acre. It is satisfactory to witness the skill with which hand-sowing is performed so far as acreable calculation is concerned; but, as a *general* rule, the delivery per square yard is apt to be very imperfect, the larger or heavier lumps flying from the hand too far, the powdery portion carried perhaps in the opposite direction by the wind. The low delivery of the distributors cures partially the latter defect—the former entirely, in the sense at least of general impartiality; but it is remarkable that Mr. Lawes, on the experimental portion of his farm, and in his comparative trials of grass manures in the park at Rothamsted, reverses this, preferring hand-sowing almost as a necessity, in order to avoid the irregularity in detail, *i.e.* per square yard, of the mechanical delivery. At Salisbury the distributors were tried with a very small quantity of black ashes upon a light-coloured rolled surface; and certainly the precision with which the particles were left sprinkled and *dusted* upon the ground seemed to leave nothing to wish for. Still, for small experimental purposes, the hand may perhaps challenge pre-eminence: fortunately the cases in which it defies the rivalry of machinery are chiefly of this kind, where the substitution is not of pressing or broad-scale importance. The distributor exhibited by Messrs. Reeves had no index of quantity; but this, they were understood to say, would, in future, be added within the price named in the catalogue.

In the class of Horse-hoes the obtuse-angled turnip-thinner of Mr. Huckvale affords a neat illustration of applied mechanical truth. At the Lincoln Meeting this implement appeared with the cutters at *right* angles to the line of draught. It was at that time pointed out to Mr. Huskinson, one of the judges, that this

right angle was in the *progression of the implement* reduced, by the relation of forces, into an *acute* angle, just as a ship sailing north feels an east wind as though it were on the north-east quarter. By the same law an obtuse angle would in *progression* act as a right angle, and, being nearer by 45 degrees on the acute side to the rectilinear line, wastes less power and friction.

There is no part of the annual Exhibition that brings together traces of the variety of local custom and fancy, verging perhaps on prejudice, more than the stands of Carts and Wagons. Why a vehicle used everywhere for the same purpose should wear such different forms, is a question that seems to occur equally to the learned and the unlearned in such matters. The difference of hilly and flat countries might be expected to imprint itself in some speciality of form; but this does not seem to hold as the governing principle of the variety, and any other it is difficult to assign. The special prize for crank-axle carts is an evidence of the interest awakened on the subject of these most important articles of every day farm use. For the purpose of loading and tipping (by far the most general purpose of all) the advantage of leverage gained by length of shaft is scientifically true, but, in practice, of secondary consideration. A lever is an article with two arms, a long one and a short one; and to move the short arm a short way the long arm has to go a long way, the power gained being the ratio of the difference. But in farm-work, and especially in earthwork of almost every kind on the farm, *pliability in close quarters* (if I can so express it) surpasses for convenience of action almost every other advantage. The cart and horse have continually to perform little feats of compact *station*, motion, turning, backing, and twisting, almost reminding one of the goat with its four feet meeting on a pivot: the illustration will at least convey the meaning it exaggerates: and if the horse could speak it would generally be to ask for room to exert his own power to the best advantage, and not for an auxiliary, which required *more* space for its application. Of course, wherever leverage *is* the chief object, as in conveying heavy well-balanced loads long distances over level roads (as in the case of the enormous blocks of stone, that visitors to Paris in 1856 will remember moving along upon high wheels, behind immense Flemish horses, in long shafts, with a perfect magazine of housings on their shoulders), the construction will be adapted to the use. For general farm work closeness and compactness are of prime importance, not merely in order that "the horse may be nearer his load," but that he and his load should be able to perform together every evolution in the smallest compass. Much ingenuity has been spent upon the different modes of loosing and lifting the *front* of the cart for tipping the load; and it is

common for manufacturers to exhibit, with satisfaction, the ease and quickness of accomplishing this; but the greatest trouble and longest delay commonly take place, not at the front of the cart, but at the back, in releasing and casting off the tailboard, owing to the pressure of the load against its inner side, so tightening it against every description of bolt or staple placed usually at *one side*, that after several trials by the hand, a rather smart blow of the spade is usually required to stir it, and then the sudden noisy fall of the tailboard either frightens the horse or makes it move on prematurely as if the load had already been tipped. The best contrivance I have ever seen for preventing this inconvenience has not yet found its way to the exhibitions of the Society. It may not be in vain to endeavour to describe it. A perpendicular iron bar or pin runs up the right side of the back of the cart, between the top-rail and the bed-rail, so as to receive, above and below, the two clutches of a forked lever whose long thin arm, acting as a spring, reaches to the *centre* of the tailboard, where, with a slight pressure, it is dropped into a latch fixed there to receive it; the tailboard is then firmly secured in its place. When the load is to be tipped a mere touch in pressing the spring of the lever lifts it out of the latch,



releasing at the same moment the two clutches from their hold upon the pin, and the tailboard comes entirely away in the workman's hand, which holds it by the lever as a handle. The release is instantaneous, the pressure of the load being only against the short ends A and B of a long lever, and is not even felt in pressing its long arm at the point C. The rough sketch given above will perhaps convey the idea of it better than verbal description can do. The hinges (and fulcrum) are *on* the tailboard, at the points D E. The wear and tear of ordinary use, so fatal generally to contrivances that appear the most ingenious, when all is fresh and new, and oiled and painted, have no impairing effect whatever upon the quick release and handiness of this fastening.

The Mowing-machine trials took place at some distance from the other implements, in "a small meadow of coarse rank herbage, intersected by open drains, and ill adapted for anything but a severe trial of the tempers of the exhibiters," to use the words of my fellow steward, Sir Archibald Macdonald, who superintended their trial. After noticing Lord Kinnaird's and Mazier's machines, he proceeds, in the communication I have quoted from, to say of the third competitor, "Clayton's machine was admirably worked by two cheerful Yankees, who made light of every difficulty, and most deservedly carried off the 15*l.* prize, doing their work beautifully, and stopping at nothing. On the following morning Dray and Co. exhibited their mowing machine, which was thought worthy of a 5*l.* prize."

Having been engaged during the time of this trial in the drill and horse-hoe fields, my first sight of this meadow was during the severe competition of the Haymakers, most carefully and admirably conducted the following day by Messrs. Clarke and Owen. The extreme coarseness and thickness of the grass, cut only the day before, converting the open drains above-mentioned into so many blind-ditches, made it indeed a trial of extraordinary severity; and the herbage being very much thicker by accumulation at the lower side of the meadow, afforded some good proofs of the separating power of the most improved specimens of this light and elegant implement, whose passage along a shorn hay-field on a summer day, scattering its light load into the air like a running halo, offers perhaps the most picturesque sight that modern agricultural machinery can boast. The careful and detailed report of the Judges of this and the horse-rake class requires no comment.

The shade of Euclid himself might have been invoked to the task of dividing into eight tolerably equal portions (corresponding with the number of the competing machines) the indescribably-shaped field of scanty rye upon which the Reaping-machines were to rehearse once again the often repeated "experimentum in corpore vili" of *wheat*-cutting. This preliminary work being, however, at last roughly accomplished (in spite of an "angulus *iste*" that would not capitulate to any form of geometrical arrangement), was well repaid by the first conclusive decision of the Judges, without motion for a new trial in August; a system of adjournment which, if carried out to the full, might with almost equal claim be extended to a large proportion of the implements belonging to the two first groups of the now triennial course, as will be found instanced in the suggestion at the close of the appended Report of Messrs. Clarke and Owen, on the steam ploughs, that their further trial should take place in April or May.

If the principle be once admitted of what may be termed the *seasonable trial* of the respective agricultural implements, it is hard to see where it could properly end, except in the reserved trial of some implement for every season, and almost every month of the year. Even in different implements of the same class, and that of the simplest, ploughs and harrows for instance, autumn cultivation, when evaporation is declining, and the moisture of the soil considerable, and spring tillage, when evaporation is daily on the increase, might bring into use and commendation qualities of an opposite character in implements of the same class—as for example in the different length of mould-board suitable for "breaking up" in the one case, and breaking down the soil in the other. It might indeed be argued, with some show of reason, that the present systematised arrangement having devoted a particular year to each group of implements, the step is not very far from the periodic to the subordinate division which the different *seasons* suggest in the relation they bear to the implements that year for trial. To the great mass of visitors to the Show-yard of the Royal Agricultural Society, who never see and hardly know of the laborious trials occupying most of the preceding week, it would certainly matter little whether they read on the label of a plough, "tried in the heavy land last *Friday*," or "last *April*," but it would matter very considerably to the judges who had to decide on the merits of the implement in its ordinary circumstances of use.

Last, and as it may prove, not least of all, comes the subject of the Steam-plough trials. It is remarkable, and may be accounted for by those who can best explain the alternations of public feeling and opinion, that at Chelmsford, the year before, the one expression heard on every side was, in various modes of exclamation, to the effect that "at last the problem of steam-culture was solved!" while at Salisbury, where the preparations for this new class of trials were on a scale far larger, and twice the number of competitors were actually on the field (several more having been entered), the general expression was quite the other way. Not that the interest shown, or the concourse of spectators, was less; but a feeling the opposite of anything like sanguine expectation, or the prospect of realized results, seemed to have gained ground during the lapse of the twelvemonth. Whether it was that there had been time to reflect that, after all, there was nothing really new in ploughing by steam, except perhaps in the subordinate ingenuity of improved details in connecting the implement with the engine, or in turning at the headlands, or whether simply because the novelty of the thing as matter of competitive trial had lost its first freshness; the eager expressions of expectation heard before, had subsided into a tone

and attitude of mere criticizing interest, somewhat difficult indeed either to accommodate, or, in the language of the police, to "keep back," so that the ploughs, and workmen attending the machinery, might have room to act, but far from exhibiting the ready and impulsive conviction of a thing accomplished, that had been noticed the year before.

Of the actual trials themselves, it is hardly necessary to say more than will be found in the brief report of the judges. To say much is impossible. Such a soil, on such a situation, hardened to such a condition not only by its own flinty nature but by the long-continued influence of one of the most extraordinary seasons that has ever been known, were enough to render any trial practically abortive. But no one who saw the work performed, even under these adverse circumstances, by Mr. Fowler's plough, could doubt that, in his case at least (not to the least disparagement of the other competitors), steam-*ploughing*, as such, had attained a degree of excellence comparable in point of execution even with the best horse-work. As to the relative economy, there seems little reason to doubt that the calculations arrived at by Mr. Amos and others the year before, at the adjourned trial at Boxted Lodge, were sufficiently near the truth to leave a very inconsiderable difference in favour of horse-work. And if this be true as a comparison merely taken acre for acre, or hour for hour, every one who knows the supreme value of *time* in the autumn months on clay soils, and the difference, in capacity of *day-work*, between a horse and a steam-engine, must be aware that a new multiplier, at least of 2, if not more, may be placed to the credit of the steam-engine, regarded as an available power, or auxiliary, when work is pressing, and when, according to a well-known poetical authority, the best, or rather only method to lengthen the shortening days is to "steal a few hours from night."

But nobody had doubted, even so far back as before the well-known experiments of Lord Willoughby D'Eresby, that ploughing, as such, could be accomplished by the use of a stationary steam-engine, instead of horses; and the trials made in this matter long before the Royal Agricultural Society took up the question and announced their premium, were not only matter of familiar knowledge, but were, in a certain sense, obsolete; and a secondary stage of inquiry had begun to grow up, viz. looking at the plough itself as essentially a horse-implement, on the one hand, and at the whole career and history of the steam-engine on the other, in its applications as a substitute for horse and manual power,—whether the reiterated endeavour to employ it through the agency of the plough (and the argument applies equally to the attempts made with the spade), was not, in fact, assuming the practicability of a combination opposed to the true mechanical

solution of a problem so important—a mistake repeatedly illustrated in the progress of the steam-engine—and that to this might be due the indifferent results obtained, economical and otherwise.

This was, and still is, a view taken chiefly by those who regard the subject rather from an engineering than an agricultural point. It is something, and no small thing, to a farmer to find a new power that can plough as well, and nearly, if not quite, as cheaply, as a team of horses. But to an engineer familiar with the unrivalled capacity and concentrated action with which the steam-engine has outstripped, almost beyond the scope of serious comparison, the different forms of muscular power—new modelling every process and recasting the very systems it has been summoned to the aid of,—the idea of a mere and almost doubtful *equality* of results, presents at once, instead of complacent satisfaction, the suspicion that there must be something fundamentally wrong. Such praise as that contained in the assertion that it " cultivates *almost if not quite* as well and economically as horses can," is to his ears simple condemnation. "Surely there must be some mistake!" is the reply which his whole experience of the preceding triumphs of that majestic power, would suggest as his first reflection. Nor is this any mere postulate of science, or conclusion from abstruse reasoning: it is open to the observation of every mind, scientific or otherwise, that can only free itself from the force of habit, and analyse the form and action of the implements themselves and their special relation to the power with which they are connected by natural affinity. And this question, far from having been set at rest by the comparative success attained in steam-ploughing (admitting that to its fullest extent), is rather countenanced by the smallness of the direct gain, if gain it can be called, and the want of simplicity (the test of mechanical as well as all other truth) by which the result obtained is still characterized.

It was under such impression, and with the view of drawing the attention of manufacturers into a broader field of enquiry than that which had repeatedly ended in unsuccessful experiments with the plough, and still later with the spade, that a premium of the unusual amount of 200*l*., increased afterwards to 500*l*., was offered, in order to promote the discovery of an instrumentality capable of developing for agriculture an economy, at least approaching if not equalling that which the application of steam power had brought to other mechanical operations. A prize so instituted, and of such amount, was of course altogether out of the category of the ordinary premiums of five, or ten, or twenty pounds, *annually awarded and renewed*, for the best plough, or drill, or haymaker, or reaper, or other implement *of the year*,

in each of the well-known classes of already *existing* farm-implements; and is, when awarded, awarded but once and for ever; and a hurried or premature adjudication of it, on the mistaken footing of an annual prize, would be, first, that the very next year might stultify retrospectively and irremediably the hasty award, by producing a machine answering literally the intention as well as the terms of the definition, by being an economical substitute, more especially for clay soils, for the there not faultless plough, or the perhaps not directly imitable spade; secondly, that should this not happen, the fact of the adjudication having once for all taken place would greatly tend to the discouragement of further enquiry or experiment of the very kind which it was originally framed to promote.

When the prize was offered, before the fever-heat of competition had set in, its purport and construction were obvious enough; yet few would be disposed to say, unless blinded by that which blinds the eye to independent truth, that the lapse of one year, or two, or three, or even more, must necessarily draw down an adjudication in the case of a prize offered under such circumstances. Years count but little in the history of invention; and Time is of its essence; both for the reaction of mind upon mind, and the maturing of those systems already furthest in advance. At the same time it was and still is open to the Society to limit the period over which the offer shall extend; and at its close, failing a more absolute attainment of the object sought, to award or divide the amount according to the comparative merit of the competitors, though not strictly coming within the wording of the premium; thenceforward, allowing a prize simply for the "best system of steam-cultivation" to take its place amongst the ordinary annual prizes of the Society.

There are, however, already many indications that the question of comparative economy, between steam and horse power in the culture of the soil, is not unlikely to pass altogether from the province of the engineer, and the adjudication that hangs upon the trial of a day. It has already become matter of experimental proof that upon certain classes of clay soils most subject to injury by the tread of horses, the economy of steam culture receives its truest and final evidence not in the mere excellence of work performed, or the merit however great of a well-turned furrow-slice in the ploughing of the field; but that a true comparative judgment must await the *reaping of the produce*, and this, moreover, not at the end of a single year or the gathering of a single crop; but that the liberty of a more perfect selection of season, and condition of soil for cultivation, and the absolute and, so to speak, *repeated* avoidance of the tread of horses, year after year, not only brings about a permanent and almost constitutional

change of character in the mechanical structure of such soils, but (in analogy with the effects of drainage) enables the adoption upon them of a SYSTEM of agriculture, to which under horse-power they were before entirely negative. If this be true,—and the practice of Mr. Smith of Woolston seems to have suggested, if it have not established it in the case of his own soil, it is a step in advance, of far higher character and emprise than any derived from a mere comparison of mechanical results upon a trial-field during the exhibition of a week.

No stronger evidence of the unsuitability of horse-work on clay soils could be adduced than the assertion often heard, on such soils, that *two years' mischief* has been done in cases where, from carting over, or ploughing, at improper seasons, the soil has been kneaded and tempered to an unusual degree. A system of culture which permanently excludes the compression of the tread year after year, and leaves such soils open and porous to the highest degree they will admit of, offers a benefit, which it is hardly rating too high to compare with the introduction of turnip husbandry and the tread of the sheepfold upon sandy and other light soils subject to the opposite evil of too great porosity.

All who are best acquainted with the peculiar characteristics and temper of what are called "sticky soils" (not due to clay alone) are aware that, to a degree which in their case can hardly be over-stated, the true cultivator and best agent of all mechanical amelioration is the Atmosphere. No cleavage by artificial means can approach its power of comminution and separation, or insure that permanence of lightened texture, by the bursting action from within which follows its effectual exposure in the coarsest form to the *natural* solvents, not of the winter's frost alone, but of every season in its turn. Compression from the treading of the team, or other causes, even in summer, when it seems most innocent, with its powdering operation upon the surface, is a specific violation of the only form of contract with Art or Nature under which such soils will develop their best qualities, in giving full action to the manure, and yielding the largest artificial produce. Even when ploughed by steam, where no compression is inflicted except that necessitated from below in the uptearing of the furrow-slice, there *is* compression sufficient to contract internally, as well as to glaze superficially, the stubborn mass, which, if not by every means coaxed to the utmost freedom and porosity, "saddens" in the opposite direction only too readily. Hence one of the reasons why such land when laid down to pasture is so long before it attains to a free and healthy turf; yet in process of time, if laid down in good heart, it does attain its proper mechanical condition, and then produces valuable herbage that develops its high chemical qualities. That the steam

plough is a comparative boon to such soils, in so far as it relieves from superficial traffic, no one can doubt; but that in the compression of the subsoil, aggravated by its increased weight, and in the turning upon the headlands, it retains unaltered some of the worst features, is equally open to observation. It is the common practice of workmen desiring to arrest the penetration or escape of water, to draw the back of the spade with a light smearing action along the bottom or side of the dam or trench. On soils with only an ordinary proportion of clay the effect is instantaneous, and lasts a considerable time. What *they* do with a purpose, the plough does incidentally, but with a far heavier and continuous path over the whole field, leaving an annual hardened under-pan, which, whether on drained or undrained land, certainly formed no part of the *intended* operation of the farmer, and is therefore demonstrably to reason, as well as by the ocular evidence left in the open furrows, a faulty action demanding, and suggesting, a remedy.

It is in these apparently inseparable traits of the passage of the plough through clay soils that the best comment seems to be contained on the question again indicated in the judges' Report on the steam ploughs,—whether they can be regarded in the light of a "substitute." There is little need to consider this. When it is already evident that a plough worked by steam-power gets rid of *some* of the evils incidental, on certain soils, to that worked by horses, it becomes quite conceivable that retaining substantially the same form, it might yet come to get rid of those remaining. The nominal objection could hardly survive the real one, since the only object of substitution is the complete removal in the substitute of the defects in the original. This accomplished, substitution is, literally as well as substantially, attained, for there is nothing in the etymology of the word to prohibit similarity of form in the instrument which shall furnish the whole of the qualities required (as may be partially instanced in Mr. Halkett's plan, in which the pressure of the plough is borne upon the rail and not by the subsoil); while it is equally true that there is nothing in the nature of the prize which prohibits a suspension of judgment, while this object may be in process of accomplishment.

What is sought for in the application of steam to cultivation is an improved SYSTEM in aid of those disadvantages apparently inseparable from horse-power on clay soils, which are specifically detrimental to their best nature and development, placing them in a scale of factitious inferiority, regard being had both to their chemical qualities, and their mechanical capabilities.

In bringing to a conclusion this Report, and with it the duties of an office, which, extending over four years, as it brings some

responsibilities, leaves behind it some experiences, I avail myself of the opportunity of noticing one or two points connected with its discharge, which appear to merit the consideration of a Society desirous of carrying out in the most efficient manner objects so intrinsically and nationally valuable as those which are committed, for the time being, to the stewards and the judges at the annual meetings in July. It has long been matter of remark, and is a constantly felt inconvenience and even hardship by the judges, that at each town in succession where the meeting is held, each equally crowded—and elevated, amongst other excitements, to the highest possible appreciation of the value of a night's lodging measured in the minutest scale of accommodation—they arrive by the train with less direction than a ticketed parcel (exemplifying that maxim in railroad economics that passengers are the only goods that load and unload themselves), and strangers to the place from first to last, they find themselves each paired in duty with some other judge, who has been launched, perhaps, from an opposite line of rail, upon a distant quarter of the town, and has there dropped at once into like unrepose and extortion. They are thus separated after their days' duties are over, at the very periods most favourable for conference on their awards and the preparation of their joint Reports; or by a still worse fate they find themselves congregated at some noisy overcrowded inn, where study and seclusion are impossible. The busiest bee makes but little honey during swarming-time, stunned and distracted by the tympanoclastic influence that custom superadds to honour such occasions, and without any practicable centre of coherence to resort to; and it is not much to be wondered at if, under such circumstances, the senior steward, instead of receiving the judges' valuable Reports fresh from the vivid pen of each day's impression and experience, has the mortification to find the great meeting dispersed, July gone—and how many months more shall I say? —before that which is never so good, never so easy *again*, is at length reduced to formal shape, but never to the first condition and quality that it wore in embryo while the little attendant incidents of thought and circumstance were fresh upon the memory.

Surely out of the thousands who subscribe to the invaluable objects of the Royal Agricultural Society of England in its Meetings, there are few who would hold the money ill laid out that provided the judges of the annual shows a central and private place of business and rest, secured beforehand, and adapted to the useful and necessary object which for the time being unites them as one body, and for some purposes (as the reapers, steam-ploughs, &c.), as one "bench."

The same remark applies in the case of the stewards themselves,

with a force diminished only by the readier pre-combination—possible but not sure—of a smaller number, but increased by the responsible and costly reception awaiting them, individually, as the temporary representatives of a great and wealthy Society. It may be that in a great body comprising so much wealth and honour, the usual experience of a narrowed selection of officers to fill important posts which such causes are apt to generate, may have been as yet indistinctly felt, obscured by the reluctance of individual acknowledgment, or the easy self-release from voluntary obligation; but if the full and conscientious performance of duties honorary in name, but becoming annually more real and exacting, be an object worth attention, it may be allowed to one for whom the four years' task is ended, to recommend that in future these honorary duties should be rendered less extravagantly burthensome. The anxious labours of long days unaided (except by some "field assistant" from the locality, utterly ignorant of the duties and embarrassed by the requirements of his new position) should be relieved from the personal inconveniences of an over-crowded town, where no head-quarters are provided by the Society for those engaged in the discharge of offices which render inadmissible the courteous offers of neighbouring hospitality;—offers that have ever marked to the Society the cordial welcome everywhere awaiting its representatives and members, and the value with which its visits are justly received.

Drills.

In the trials of the various descriptions of drills at Salisbury, the judges were agreeably surprised, and astonished, at the numbers brought for exhibition. The workmanship of many was of a very superior description, and the general work in field operation was good.

To commence describing some of them, we must begin with the universal drills, and first with that of Messrs. Hornsby, which won the first prize, and whose adaptation of vulcanised Indian-rubber tubes* is, we think, a great improvement on the old tin pipes, and one, we think, which ought to be followed by all drill makers. Their plan also for altering the position of the seed coulters when sowing guano at the same time, is a great point gained, as it prevents the necessity of placing the seed directly on the manure. This machine worked admirably; the seed box is balanced on its centre for hill sides, and can be regulated while at work. The manure and seed coulters are on different levers, and their depth is regulated by weights. This drill cleared itself of rubbish better than any of the others that were tried. The coulters are all of wrought iron, and steeled.

To Messrs. Garrett we gave the second prize for an excellent machine, fitted with the broadcast manure distributor of Mr. Chambers; this we found an excellent drill; but while we praise the work done by both the above machines,

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* Which we believe Messrs. Hornsby first produced at the Royal Agricultural Society's show at Exeter.

we do not approve of the combination which is found to be necessary in the universal drills, causing them to be very expensive and heavy. Messrs. Holmes's drill in this class was commended.

In the class of corn drills we gave the first prize to Messrs. Holmes; it is an excellent machine, of light draught, and the price moderate compared with the others on account of its greater width, viz. 2 feet. It has a brass index to each slide, and thus a regular supply is kept up to each coulter. The steerage from behind is good, and it has a useful adaptation for hill sides. In this class we highly commended the drills of Messrs. Hornsby and Garrett.

In the class of small occupation drills we gave an equal prize to Messrs. Garrett, and Messrs. Hornsby, both machines well worthy the attention of small farmers; both did excellent work. We also commended Messrs. Holmes's.

In the class of ridge drills for turnips and mangold wurtzel, we cannot say too much in praise of the work done by Messrs. Hornsby's machine. No alteration of spindle is required, and the patent rollers are made for different width of ridges, and are easily altered; it has a reverse motion for the manure rollers.

Messrs. Garrett received the second prize for a very good machine; it is fitted with Mr. Chambers's manure distributor, and worked very well, but the ridges were not left as perfect as by the preceding one.

Messrs. Holmes's is a very good machine, but leaves the ridges too flat. While naming these three last machines, we beg to observe there is great difference of opinion amongst farmers, whether it is better to leave the ridges high or to flatten them; we think that flat ridges are not so affected by drought as higher ones, but this is quite a question between heavy and light land farmers.

The dropwater-drill of Messrs. Garrett, the invention of Mr. Chambers, deserves every commendation; the work done by it was most regular and efficient; it did not appear the least liable to choke, or to drop the water, except in the exact place required. We gave it the first prize.

We commended the drop water-drill of Messrs. Reeves, but the water was delivered in rather too continuous a stream to be perfect.

Messrs. Reeves had also a new implement, very useful and moderate in price, for depositing any dry artificial manure, in four rows, 18 inches apart, without mixing ashes. We awarded to it a medal.

To Messrs. Howard, of Bedford, we awarded a medal for a "Drill Presser" to follow three ploughs; it did beautiful work. The pressers have flat edges, and the seed falls in the trenches made by them, as if broadcast; instead of, as with a drill, one on the other. Two horses work it with ease, and it covers the seed as soon as it is sown.

Having now noticed the drills to which we gave prizes, we must add that many excellent machines were brought to trial, but amongst so many we were obliged to draw a line, and taking all the pains we could, we cannot compare the work done to that of the prize machines. As judges we, of course, had to look at the work done *in our presence*, not at what we were told a drill may be *able to do;* we looked strictly to work and workmanship, but to name all our likes and dislikes of so many different machines would fill a volume, while still few might agree with our opinion, on their own use and experience of this or that machine. Bearing in mind the *triennial* trials, we sifted the merits of each drill to the best of our abilities; we wish to make no excenses for mistakes if we made any, but we are well aware there were many disappointed makers; and if we had been guided by all we were told, we might certainly assure the public there was not a bad drill in the yard, though we must add, that after trial, some makers had the candour to own that their drills were deficient. The length of time that was to pass before another trial of these machines could take place, made us try many that we should otherwise not have taken to the field; in order that, while endeavouring to do our duty to the

Royal Agricultural Society, we should not disappoint any one of the candidates. Before closing this report we must again say we do not approve of the combined universal drills; a good manure distributor and a corn drill are much better separate, instead of so much alteration and laying aside of this and that part of the machine. The fore-steerage, now so much in vogue, also causes the attendance of an extra man and 4*l.* 10*s.* extra in the first cost of the drill. This latter item is a needless expense when we see the work so well done by drills only fitted with back steerage.

Stand.	Article.	Name.	Price.			Remarks.
			£.	*s.*	*d.*	
		Universal-Drills.				
9	1	Hornsby ..	51	0	0	Prize of Five Pounds.
28	1	Garrett ..	51	10	0	Ditto Three Pounds.
65	2	Holmes ..	31	10	0	Commended.
		Corn-Drills.				
65	3	Holmes ..	27	2	0	Prize of Seven Pounds.—Two feet of extra width.
9	2	Hornsby ..	26	10	0	Highly commended } Fore Steerage,
28	7	Garrett ..	27	0	0	Highly commended } 4*l.* 10*s.* extra.
9	3	Hornsby ..	29	10	0	Highly commended.
		Drills for Small Occupations.				
28	10	Garrett ..	19	5	0	Prize of Two Pounds.
9	5	Hornsby ..	19	5	0	Ditto ditto.
65	4	Holmes ..	19	10	0	Commended.
		Ridge-Drills.				
9	7	Hornsby ..	29	0	0	Prize of Five Pounds.
28	4	Garrett ..	24	7	6	Ditto Two Pounds.
65	6	Holmes ..	25	0	0	Highly commended.
		Dropwater-Drills.				
28	11	Garrett ..	33	10	0	Prize of Four Pounds.
35	3	Reeves ..	28	10	0	Highly commended.
		Patent Economical Drill. New Implement.				
35	13	Reeves ..	12	0	0	Medal.—If with wood wheels, 1*l.* extra.
		Drill-Presser.				
47	1	Howard ..	16	0	0	Medal.

H. B. Caldwell,
J. Druce.

Having bought a drill presser at Salisbury, and having since worked it on his farm, the undersigned only thinks it strict justice to Messrs. Howard to express his decided approbation of it.

H. B. Caldwell.

Manure Distributors.

The portion of the prize list which was allotted to us comprised the Manure Distributors and the miscellaneous department. The sum of 20*l.* was to be awarded to the Distributors, but for the miscellaneous articles we had no money prizes, and only such of the medals as the judges in the other classes could spare. Of the twelve which the Society offered they took but five, leaving us seven to award over our large and varied department.

The dry manure distributors were the first selected for trial. These machines were required to sow half an acre at the rate of 2 bushels per acre, and half an acre at 30 bushels; also to distribute wet, coarse, and fine manure. Of course the price, workmanship, and simplicity of the machines were taken into consideration. Six Distributors were brought to the trial field, but it was soon evident that the three foremost were those of Messrs. Chambers, Reeves, and Holmes. The first and the last have now been some time before the public; a description of them, therefore, would be superfluous, especially as an account of them, and their lengthy trial in 1854, was detailed by the Carlisle judges. Mr. Reeves's distributor is quite new. It is very simple in its construction. There is only one box in which revolve a row of Archimedean screws. These turn the manure out at holes in the bottom of the box; a slide diminishes or increases the openings, and thus determines the quantity to be sown. The price (10*l.*) is greatly in its favour, but then its extreme simplicity renders the cost of making it very trifling. Neither the materials nor the workmanship were first-rate, and there must be a considerable profit to the inventor at the present price. On the whole we were much pleased with the machine. It sowed a small quantity of fine manure with great regularity, and all other sorts very fairly. It requires a stirrer in the upper part of the box. This and one or two trifling alterations in matters of detail which we pointed out to the manufacturer will tend greatly to improve this machine. Mr. Holmes's distributor sowed coarse manure better than any of the others, but Mr. Chambers's seemed to us the more generally useful machine, as it acted well in distributing all the manures, whether dry or wet, coarse or fine, a large quantity or a small. The price is high, 20 guineas; but there is a great deal of work about it, and that work is turned out in first-rate style. This is essential, for such corrosive manures as guano, salt, and the like, speedily damage all iron work which is not well made, and of the best materials. We awarded Messrs. Garrett and Sons, for Chambers's broadcast manure distributor, the sum of 8*l.* To each of the other two we gave a 5*l.* prize.

It has recently been said that it is the duty of the Implement judges to point out to the public the shortcomings of the unsuccessful machines. We do not see the necessity of this. We explained to the makers, as courteously as we could, what we thought the chief defects in their machines, but those remarks do not want to be paraded before the public. The absence of a prize or a commendation will show we did not appreciate this or that implement very highly, and as long as prizes are awarded by the Society they ought to be considered as certificates of merit, and direct the agriculturist to the best implement in its class. We can confidently recommend any of the three Salisbury prize-Distributors to our brother farmers. If they want a machine to sow any sort or any quantity of manure, and do not mind the price or its weight, Chambers's is the best; if they require one to sow coarse or long manure, Mr. Holmes's is to be preferred; but if they wish for one that will distribute a small quantity of fine manure with great exactness, then we should recommend Mr. Reeves's. And this, after all, is a great point; we do not so often want distributors to scatter a lot of rough stuff, as to sow from 2 to 4 bushels of highly concentrated manures. We have said that Mr. Chambers's machine was well made. We do not mean by this that the oak was beauti-

fully varnished, the iron work well burnished, or that the paint was of the softest blue, but we mean that the workmanship of all and every part of the machine was strong and excellent, and we were fully confirmed in our opinion by the willing testimony of the consulting engineer. Then as to the length of the trials. In a very short time we satisfied ourselves as to which were the three best machines. Some of the distributors we did not require to do much. One can see as well in five minutes as in an hour what a machine *cannot* do, but it requires a long and varied trial to say with certainty which machine, out of a lot of good ones, is the *best.*

The liquid manure distributors were next tried. We consider these distributors should also serve as water carts. Sowing artificial manures by such means we think useless, and therefore did not much approve of Mr. Reeves's ingenious machine for that purpose. The liquid drill may be of great service, but when artificial manures are to be sown with water, they are best deposited in the ground and covered up, not scattered over the surface of the soil. There is plenty of liquid manure which now escapes from our yards; we do not want to make more, but rather economise what we have. The chief supply is in the winter; and as the distributor is hardly wanted in the summer months, it should serve on the farm to carry water when most needed, and when it would be otherwise idle. We tried several; none showed any great superiority, and but very few scattered the water well. Mr. James's worked the best; it has a large trough for distributing the liquid, and when this is removed it becomes an excellent water cart. It has two strainers which prevent the admission of anything that would choke the delivery, and the tap is easily worked by a man who rides or walks in front. It holds 270 gallons and scatters the liquid 12 or 14 feet wide. The cart is all composed of wood, well seasoned, and well made; and so it ought to be, for 24*l.* is a great price. We awarded Mr. James the prize of 2*l.*

Wm. Chalcraft.
Clare Sewell Read.

Horse-hoes.

The statistics of the Society will show the vast increase in the number of the implements that were exhibited at the Salisbury Meeting, and we are enabled to report favourably of the continued improvement made from time to time in their general details, not only in simplicity of construction, but in workmanship. These improvements have been noticed before; they still progress, not only in the articles exhibited for trial, and which came under our adjudication, but in those which wait their turn in the triennial test. The horse-hoes, both for corn and roots, were an interesting class. Of these 28 entered for trial, and 26 came to the field, and received our best care and attention. Some of these hoes were adapted for both corn and roots, being so arranged as to admit of changes in the details so as to accommodate wide or narrow drills. Although this may be apparently a convenience, yet we doubt if, in the end, it is so, satisfied as we are that if a machine or implement will do one thing, and do it well, it is sufficient. The principle of "general purposes," and the ease and facilities of change from one kind of work to another, have been generally approved until a few years ago. This is not at present so much in force, and, as before observed, to do one thing well appears to be sufficient. In those districts of the country where the Northumbrian or ridge system of growing turnips is practised (and this, it must be admitted, is a very extensive district), a common rule is observed of drilling two rows at once by means of a double ridge drill. However imperfect the work may be, it is obvious, that if the two rows are not always

straight, they *must* be parallel. Hence it appears that if a horse-hoe can be constructed to hoe two rows at once, or, as it may be better expressed and understood, hoe *one space* and two *halves*, double the quantity of work will be accomplished. The same rule holds good with regard to turnips on the flat, where four-row drills (which is frequently the case) are used. And as hoeing two rows of turnips at one and the same operation is only moderate work for a horse, we incline to believe that this kind of horse-hoe will be most required. Several hoes were exhibited and entered for trial, the object of which was to thin the plants by striking them across. Of this class Messrs. Howard exhibited one (stand 47, article 5) on the principle of a revolving harrow, and intended not only to thin the plants but to loosen and disturb the crust which frequently surrounds them. Although this implement would be used *only* in a busy season, and when men were otherwise employed, it has some claims to notice for ingenuity, as well as novelty in construction. Mr. Huckvale's revolving horse-hoe (stand 5, article 47) is improved since last year. The stroke across the turnips is now taken obliquely, so that the machine being in motion the action of the knife is straight. The hoe worked well, but it appeared to require some further amendment, and we venture to hint that if the front wheels could be made to work at pleasure either on the ridge or in the furrow, it would materially assist in guiding the machine in the work. And we think it would work steadier if the side hoes were to take more of an anchor form behind the frame of the machine. And perhaps the knives would carry less dirt and weeds if they were narrower, and the space between them less, so that less turnips might be left in the tuft. We are anxious to see this implement brought into general use, and for these reasons we have ventured an opinion and given it a *commendation*. Mr. Garrett's revolving horse-hoe (stand 28, article 16) was on a similar plan to Huckvale's, but different in construction, and not equal to Huckvale's in separating the turnips and carrying the dirt away. In the class of revolving hoes must be noticed Mr. Eaton's (stand 20, article 1). This implement worked better on a second trial than the first, but yet required a good deal of power to hold it in proper position. We think this implement and others of a similar class would be improved if those parts exerting most power or doing most work could be placed in the aft part of the machine, instead of the centre or front, as they generally are. This arrangement would give increased stability to the machine, and cause it to follow the line of draught with greater accuracy.

The following table shows a classification of horse-hoes, and we think it would be well if the Society's premiums for the future should distinguish between hoes for roots and hoes for corn :—

Prizes and Awards.	Stand.	Art.	Exhibitor's Name.	Price.	Remarks.
£. s. d.				£. s. d.	
3 0 0	28	13	Messrs. Garrett.	19 0 0	Worked well on hard ground, and crossed turnips on the flat admirably. This machine well deserves its high reputation.
2 0 0	71	1	William Smith.	8 10 0	This machine worked well on trial; it is not large or cumbrous, and the price moderate; it is a really useful machine.
2 0 0	125	8	Priest and Woolnough.	19 10 0	Worked very well on the hardest ground, and capable of arrangement for hoeing turnips on ridge or flat, having a parallel motion and adjusting bars.

HORSE-HOES—*continued*.

Prizes and Awards.	Stand.	Art.	Exhibitor's Name.	Price.	Remarks.
£. s. d.				£. s. d.	
1 10 0	110	3	E. H. Bentall.	3 13 6	This machine worked well and required very little holding; and chiefly made of iron. It was on Bentall's broadshare principle, and intended to do one space and two halves, or only one space. It is durable and inexpensive.
1 10 0	83	2	Hugh Carson.	3 10 0	Like the former; worked well, and made of wrought iron. It is capable of being adjusted to hoe one space only, or one space and two halves. In working the latter, perhaps more strength to the implement would be requisite.
Highly commended.	53	1	Henry Cogan.	10 10 0	A very useful implement for hoeing and cleaning land; did its work well.
Ditto.	47	2	Messrs. Howard.	3 10 0	This machine worked well, only doing one row on turnips at once; with lever harrow complete, as a corn hoe doing three rows at once, it did not do a sufficient quantity.
Ditto.	74	6	J. Stalker.	3 7 6	The arrangements and the details of this implement were very good, but the working parts were not wide enough, doing one row only.
Ditto.	65	15	Holmes and Son.	5 10 0	A very useful implement, particularly for turnips on the flat, doing three rows.
Ditto.	81	17	William Busby.	2 10 0	A strong implement, doing one row only, and very cheap, but scarcely wide enough in the working parts.
Ditto.	101	1	Ransome and Sims.	3 6 0	Very good in workmanship and details, worked well, would run steadier if it were heavier in itself.
Ditto.	98	3	Mapplebeck and Lowe.	1 15 0	A useful and cheap implement, doing one row only.
Commended.	12	1	John Green.	12 12 0	The lever to this implement is a useful arrangement, doing three rows on the flat, work moderate.
Ditto.	61	5	A. and T. Fry.	3 15 0	This implement contains some novelty, and is intended to vary the working width when in motion. When the work is accurately done this scarcely seems necessary. It worked well on one row.

Wagons and Carts.

The Wagons and Carts form an interesting variety of useful implements, having frequently some peculiar local fashion, supposed to be best adapted for local wants, or it may be local prejudices. In the list of premiums offered by the Royal Agricultural Society, at the Salisbury Meeting, is one of a novel nature, drawing the attention of cart builders. It may be as well to repeat the words of the prize as in the list (No. 11):—"For the best one-horse cart, constructed with a view to lightness of draught, and the ready loading and unloading of farm-produce; qualities, it is submitted, which may be best attained by the judicious use of long shafts, high wheels, and cranked axles." This kind of cart as used in towns for the conveyance of heavy goods, and where the load is received at the back end of it, is rarely intended or built for "tipping." In the case of unloading farm produce tipping is absolutely necessary, and this is one of the stipulations in the premium offered. Some of the cranked axle carts exhibited did not succeed in tipping the load as might be expected, having gone to an extreme in high wheels and depth of crank. T. Milford and Son (stand 124, article 3) succeeded in overcoming this difficulty by tipping the body of the cart on the lower part of the crank. This was a novel and ingenious contrivance, and the only one of the kind exhibited.

In the construction of carts of this, or any other description, it is necessary to observe the rule, that as the height of the wheels increases the length of bearing on the axle must be increased in a corresponding ratio. This was

Premium.	Stand.	Art.	Exhibitor's Names.	Price.	Diameter of Wheels.	Power required to move empty Cart.	Net Weight.	Remarks.
£. s. d.					feet. in.	cwt. qrs.	cwt. qrs.	
4 0 0	124	3	T. Milford and Son.	18 0	6 0	2 0	10 1	This cart was manufactured in a first-rate manner of good materials in all its details; tipped easy and travelled well, having long shafts and plenty of room.
4 0 0	81	1	William Busby.	15 0	5 1	1 3	10 0	Carried its load well, good materials and workmanship, tipped easy.
3 0 0	61	12	A. & T. Fry.	16 16	4 10	2 1	10 1	Made of good materials and excellent workmanship, tipped easy.
2 0 0	59	11	Alfred Crosskill.	18 0	6 0	2 0	12 1	A good cart; travelled well, and of excellent materials and workmanship.
2 0 0	47	11	T. and F. Howard.	17 0	5 2	2 0	10 2	A good cart; materials and workmanship very good.
Silver Medal.	124	2	T. Milford and Son.	15 15	5 6	1 2	8 3	A low cart on the body with high wheels, contrived with axle above the beam; light in draught and light in itself.

not the case generally with the cranked axle carts that were exhibited, and some did not travel with the precision required on a smooth and even surface, but rumbled laterally, giving evidence of want of nave bearing on the axle; and this would become more apparent and injurious as the wheels got older. We fully believe that it would be an advantage in both carts and waggons (especially to carts), if the intentions of the Society were carried out in desiring longer shafts. Without doubt the horse or horses would have greater power and leverage over the load behind them, not only in turning, but in ascending or descending hills. The common impression with carpenters (and farmers fall into the same way of thinking) is, that the nearer the horses are to the work the better. We know of no mechanical law to guide the public to these conclusions, and practical men are satisfied that, in the present instance, longer shafts than those now in common use would be a great advantage, whether the wheels be high or low, and the axles cranked or otherwise.

We were most anxious to arrive at a sound conclusion in awarding the premium, and, assisted by Mr. Amos, tested these carts in several ways: first, by loading each with a given quantity of earth, observing their travel, and trying them at pitching their loads in a field which, notwithstanding the dry weather, unfortunately proved more like a bog than what it appeared to be, and afterwards testing the carts when loaded by the dynamometer. The result is given on the preceding page.

Other carts in this class were exhibited, but they had some defect; not so much in workmanship or materials, but in construction either in build or mechanical arrangement, to which allusion has already been made.

In the class of wagons there were fifteen exhibitors, having a great variety of style and local fashion. We willingly concede a fashion to some extent, but where local fashion or prejudice runs counter to common sense, we may record our objections to it; and any carriage, be the same wagon or cart, so built as to lift the loading and unloading inconveniently high, is an outrage on labour and opposed to the principle of economy now sought for in every department of trade and agriculture. A wagon with low wheels and a high body must be an absurdity in any part of England, and fashion ought not to demand such exactions any longer. Time and the visits of the Royal Agricultural Society will gradually reconcile one county fashion with another, so that a convenient and handy wagon, regardless of fashion, will be found in every nook and corner of the land.

Appended is a list of premiums given to wagons.

Prizes and Awards.	Stand.	Art.	Exhibitor's Name.	Price.	Remarks.
£. s. d.				£. s. d.	
2 0 0	124	4	T. Milford and Son.	25 0 0	Cheap and well made, the arrangements and workmanship excellent, and well adapted for two or three horses.
2 0 0	93	1	John Kiddle.	17 0 0	Made of good materials, and very cheap at the price advertised.
2 0 0	33	1	John Gifford.	30 0 0	Made of excellent materials and workmanship; the price is high, and it is not made entirely for farm purposes.
2 0 0	50	4	Alfred Crosskill.	28 10 0	Very useful, and not expensive considering all its parts: the arrangements for the lock are different to those in common use, and of some advantage in short wagons.

Prizes and Awards.	Stand.	Art.	Exhibitor's Name.	Price.	Remarks.
£. s. d.				£. s. d.	
1 0 0	11	3	Isaac James.	28 0 0	Cheap for farm or other purposes; the break is well arranged.
1 0 0	142	1	George Milford.	23 0 0	A useful and cheap wagon, with good workmanship.
Highly commended.	142	2	George Milford.	21 0 0	Similar to the former, but without break. Both cheap.
Ditto.	50	3	Alfred Crosskill.	31 19 0	Excellent materials and workmanship: the double break adds to the price, but the arrangement, for hilly countries, is very good.
Ditto.	87	20	William Dray and Co.	27 0 0	The wagons in this stand were all of a light and useful kind, some for farming, others for commercial purposes, having Government axles.
Ditto.	87	19	William Dray and Co.	24 0 0	A van, rather than a wagon, having a tent roof with waterproof covering; this carriage deserves a high commendation.

We now come to the ordinary class of carts, in which there has been, since the establishment of the Royal Agricultural Society, a most formidable competition, the makers having from year to year continually made some improvement in the details, and in the simplification of the implement. We do not consider ornamentation necessary for a cart or wagon destined for the fallow field or the dung heap, especially should it appear to have added to the cost, but some licence may be given in this respect to carts not entirely intended for farm purposes.

The following are the awards of the Society's premiums:—

Prizes and Awards.	Stand.	Art.	Exhibitor's Name	Price.	Remarks.
£. s. d.				£. s. d.	
20 0	81	3	William Busby.	15 0 0	A useful cart for farm or road purposes, having plank sides and bottom, held together by bolts and screws; materials good.
2 0 0	80	4	William Ball.	14 10 0	Like the former, a useful cart, but not made in the same way; materials good.
2 0 0	124	1	T. Milford and Son.	15 0 0	Milford's carts have always been good, they are equally good this year; workmanship and materials excellent; the cart has a large body for harvest purposes.
2 0 0	79	34	James Woods.	14 10 0	A very good and roomy cart, having English oak bottom and plank sides, at a moderate price; the harvest frame is well arranged.
1 0 0	50	6	Alfred Crosskill.	15 15 0	Crosskill's carts have always had a high reputation; the wheels are particularly strong.

Prizes and Awards.	Stand.	Art.	Exhibitor's Name.	Price.	Remarks.
£. *s.* *d.*				£. *s.* *d.*	
1 0 0	47	10	Messrs. T. and F. Howard.	14 0 0	A cheap and useful cart; it would be improved if the body were larger.
Silver Medal.	124	2	T. Milford and Sons.	15 15 0	Somewhat new in principle, having high wheels and long shafts. The object of the crooked blades is to obtain a lower body, and this is accomplished, but it will not add to its strength.
Highly commended.	130	4	Arthur Silcock.	16 0 0	We do not think it necessary to make special remarks to each of the carts commended and highly
Ditto.	142	3	George Milford.	14 0 0	commended. The price of these implements varies, as will be
Ditto.	103	9	H. A. Thompson.	14 0 0	seen, and indicates a difference in materials, or workmanship, or
Ditto.	89	5	H. Hayes and Son.	13 15 0	both. The highest priced cart is not always the best, nor the
Ditto.	86	1	W. Crossley and Son.	15 0 0	lowest the cheapest; and we think it would be quite as well,
Ditto.	61	11	A. and T. Fry.	15 0 0	if, in future exhibitions of this kind, *the weight of each cart*
Ditto.	58	19	Brown and May.	12 0 0	from a public weighing machine were appended to it. This would
Ditto.	26	2	Samuel Garn.	13 13 0	be some guide to the Judges in their decisions; and we would
Ditto.	20	3	John Eaton.	11 0 0	also recommend that in the class of carts and wagons, no paint
Commended.	136	12	Robert Lane.	14 0 0	should be used as a covering to defects; they should be only
Ditto.	92	1	John Kendall.	10 10 0	varnished.

J. Jephson Rowley.
Fielder King.

Mowing-Machines.

Our department as judges included Mowing-machines, Haymaking-machines, Horse-rakes, &c., besides the reaping-machines and steam-ploughs in conjunction with all our colleagues.

Our first duty commenced with mowing the clover and grass. We had in reality only two competitors, as the other two machines in competition in the clover-field declined the very severe work of the meadow-grass provided for them or sustained a very imperfect trial therein. In the clover-field all the machines made tolerable work. Lord Kinnaird's machine failed to cut so close to the ground as we required, and owing to loose stones (which also impeded the other machines) and other causes, the work was not as a whole satisfactorily performed; occasionally it did well. Mazier's machine had great difficulty in cutting closely down; it is a machine of simple construction, but, in studying simplicity the more important consideration of steadiness in work has been in a degree overlooked. Clayton's American Eagle Machine performed its work very satisfactorily, cutting low and clean without at all distressing the horses by its required pace or draught; both were moderate, although it took a large average breadth. The mode of communicating motion to the cutters is novel; it is from the circumference of the main

travelling wheel or wheels by a "cam movement." The cutting is also new; it is performed by two rows of blades, the upper ones being in motion, and the lower fixed. They are easily replaced, and are less liable to clog or choke than the old plans of cutters and guards. Messrs. Dray and Co.'s (Catchome's) machine, made good work in the clover-field, but appeared more liable to obstructions or hindrances: it did not take so great a breadth as the Eagle machine, and yet the labour appeared to be harder. These machines were subsequently tried in the grass-field, and certainly a severer test could scarcely be found. The grass long, old, and much entangled, an experienced mower was greatly perplexed at it; added to which there were a number of surface-drains, deep, and running in various directions. Here the superiority of the Eagle machine was manifest; by the balancing arrangement it was enabled with comparative ease to overcome the difficulty of crossing the grips; but no machine could cut the grass properly: it foiled the scythemen. However, some fair work was done by it, and by the machine of Messrs. Dray and Co.; indeed, the compact make and strength of the latter enabled it to make the better work in the rough grass. Lord Kinnaird's machine was not able to get through these formidable obstructions satisfactorily; but it is a highly useful machine at a moderate cost. We were gratified in coming to decided adjudication at once. We awarded the first prize of 15*l.* to the Eagle machine, and 5*l.* to Messrs. Dray and Co.'s (Catchome's) machine.

Haymakers.

Our next duty was to test the Haymaking-machines on the newly-mown grass. It was an interesting trial, and we had considerable competition; we therefore divided the 10*l.* at our disposal into four prizes, in order to be a token of merit. Mr. Nicholson's machine scattered the heavy lumps of grass with perfect ease; nor could we clog it. Its teeth are in good form, it clears itself without difficulty, and has a rapid and good backward motion. The mechanical arrangements are simple. The adjustments for altering its motions, raising and lowering the forks, and to prevent clogging, are very satisfactory. It is fitted with tubular shafts. Price 15*l.* We awarded it our first prize of 4*l.* Messrs. Barrett, Exall, and Andrewes' machine was put through severe trials to test the liability to choke. We could not choke it; and after a close competition with Messrs. Smith and Ashby's machine, we awarded it the second prize of 3*l.* It is of simple construction and easy adjustment. The oiling parts covered with a cylinder, and it has a lever-reversing movement. Messrs. Smith and Ashby's came next into our favour. It did its work admirably both in its backward and forward motion; in the severe test we adopted it betrayed symptoms of clogging, but did not actually do so. It is of excellent construction; its various adjustments for facilitating it in work, reversing its action, and raising or lowering its tines, are very good and simple. The price is 15*l.* 15*s.* Though higher in price than some, none have superior workmanship. Prize of 2*l.* Mr. H. A. Thompson's came next in trial and favour. It proved well in work in every respect. Its mechanical construction and the adjustment for giving it steadiness in work are very good. Its tines have double prongs to make its forward and backward action more effective. Price 16*l.* 16*s.* Prize 1*l.* Messrs. Ransome and Sims' is the same with Nicholson's patent, and is beautifully manufactured. The price, 16*l.* 16*s.* Wyatt's is almost a new invention, and has several peculiar adaptations which are very ingenious. It is well made, and price moderate, 14*l.* 14*s.* It worked fairly, but our severe test choked it. Samuelson's machine, by some unhappy adjustment, did not work satisfactorily. Price, 13*l.* 13*s.* Silcock's machine also failed in trial; this was also owing to some irregularity in adjusting it for work. Lane's machine failed from similar causes. Exhi-

bitors should be very careful to come prepared for work, as the judges have no time to waste. Mr. Nicholson exhibited a large two-horse machine upon his usual pattern, but it did not work quite so well; one set of tines was not wholly free before the grass was caught by the following set on the cylinder. We awarded it a commendation. Our best attention was given to test the varied merits of this class of machines: and it is only when they come together in such close competition that we are privileged with a comparison of such merit. We believe we have equitably dealt with each as it appeared in trial before us.

Horse-Rakes.

The next class was that of Horse-rakes. In this class we had a greater competition, and only partially withered grass, not hay, upon which to test them. We had thirteen competitors, and a very small field. However, we put them all upon the same trial: first to draw the heavy tedded grass into rows, and then to make the intervals clean. It was soon evident that some rakes would not do this kind of work at all, while others were quite *au fait* at it; we readily admit this was not their legitimate use, but if capable of doing this, all the better. Rowsell's large wind-rowing rake was put to this work, and did it, as well as afterwards raking the rye-field in so effectual a way, that we recommended a silver medal to be given to it. Upon the whole we thought that under these arrangements we could see sufficient in the various trials to enable us to give a fair decision. The first rake tried was one exhibited by Mr. Samuelson, the invention of Marychurch of Haverfordwest. It has a self-relieving movement, or can be relieved by a string held by the leader. It drew up the grass tolerably, and worked pretty well in clean-raking. We highly recommended it, chiefly for the peculiarity in the delivery, being nearly self-acting. Price 8*l.* 8*s.*; taking, 6 ft. Mr. Fisher's came next. The beams are of tubular iron, and the teeth of spring-steel, curving forward. It worked well in every respect, and the material and simplicity of its construction we approved, and awarded it our lowest prize of 1*l.* Messrs. Howard's rake next came before us. It is also fitted as a weed extirpator after Phillips' patent. The teeth are of steel, of great length, curve, and capacity, so that obstructions rarely interfere, and they can be adjusted so as to ride over the ground and gather the barley without soil. The lifting bar is above the teeth, giving it an advantage in filling and emptying. The links in lifting bar rather objectionable. Takes 7 ft. 3 in. It drew up the heavy grass admirably, and its clean-raking was perfect. The prize of 3*l.* Williams's rake was next tried. It is a long and superior rake, taking 7 ft. 6 in. The compound lever makes it easy to lift, and its arrangement for permitting the teeth to swim over the surface to gather up barley without soil is good. It drew up grass and did its clean-raking well. Highly commended. Messrs. Barrett and Co.'s came next. It is a useful implement: the teeth are too short and not heavy enough for drawing into rows. Is good at clean-raking. Messrs. Smith and Ashby's was next tried. It is the old original Stamford rake improved, and few excel it. It is light, but works remarkably well. The teeth are steel and angular, not sickle-shaped. It drew up heavy grass better than any other, and it clean-raked admirably; it is also adapted for twitch. A prize of 1*l.* Messrs. Cooper and Co.'s rake was next submitted to us. This is the counterbalance lever-rake, *i.e.* a weighty casting at the other end of the teeth. It would not draw up the heavy grass on this account. The balancing makes it useful for barley raking: it has weed-extirpating tines. We highly commended it for this balancing principle. Messrs. Ransomes and Sims' rake came next. This is a very good rake, and well made; the lift is rather hard. It has a sliding rod to take every alternate tooth out of work when required:

sides regulated for hill-sides. Its drawing up and clean-raking were equal to any. Prize, 3*l*. Mr. Thompson's rake drew up the grass well in large rows. It has a peculiar combination of levers so as to insure a receding motion of the teeth when raised; its arrangements are good. Mr. Woodburne's rake is smaller: too light for drawing up grass; did very well in clean-raking. The teeth are confined by links. It has a simple plan for holding it safe when travelling. Mr. Urry's rake is well arranged without complexity. The teeth are made to rake more or less on their points by winch, worm, and pinion. Its excellence in construction, work, and price (6*l*. 15*s*.), led the judges to award it a prize of 2*l*. Mr. Silcock's rake worked freely in clean-raking; its bar is somewhat detrimental, and it cannot draw up grass. Mr. Rowsell's American rake is chiefly adapted for wind-rows or barley raking. Its principal adaptation is to draw up hay into large wind-rows for cocking, which it does admirably. The long teeth are fixed into a large head or beam through a mortice, to be taken out at pleasure, or added for barley-raking, and it is guided by two handles nipping two of the tines, which all project equally from either side of the beam. When full, the workman just lifts the hinder teeth, this causes the front teeth to catch the soil, the rake is then thrown over, and leaves the load clear. Price 28*s*. and 40*s*. respectively. Silver Medal.

We would observe that the rake-teeth were all of iron or steel, except Rowsell's, and for the most part sickle-shaped. It was clearly manifest that the larger and heavier teeth had the advantage in our trial, and those having the best regulating adjustment to lower or depress the teeth in work met our high approval. The whole class of horse-rakes was a credit to our makers, and a boon to the farming public.

WILLIAM OWEN.
JOHN CLARKE.

REAPING MACHINES.

The trial of reaping machines commenced on the evening of Saturday, July 18, in a field of rye, a very moderate crop and very foul.

The different portions of ground were marked out by the Stewards, and the lines dividing the portions were cut out by Mr. Crosskill's machine in a most efficient manner; for this work it has a decided superiority over the other machines exhibited, but which superiority was counterbalanced by the very easy and excellent work of Messrs. Burgess and Key's machine, which was brought out with the new addition of a spiral screw on the side of the machine next the standing corn, which caused all the corn it touched to be brought inwards, and thus conducted it to the platform, so that the swathe was laid in a most regular form, and perfected the side delivery. The horses walked at a moderate pace, and the only person attending the machine was the driver. To this machine the Judges unanimously allotted the First Prize. The other machine of Messrs. Burgess and Key we highly commended for very efficient work.

Mr. Crosskill's work was well done, but the swathe was not so well laid, nor so good and even a stubble left, as by Messrs. Burgess, and this we believe was caused by its not being well adapted to cut across furrows to make perfect work; and the scattered straws left on the swathe we think owing to a fault in the construction of the endless band for the side delivery. This machine has two men to work it, but cuts fast, though the power required is more than that which is consumed by Messrs. Burgess and Key's machine. We gave it the Second Prize.

The Third Prize we allotted to the machine exhibited by Lord Kinnaird, which worked well; but we thought the horses were driven too fast for farm horses, and the machine, although cheaper than those spoken of above, was not

to be compared to them for workmanship. The driver was the only attendant necessarily required.

Dray's (Palmer's) machine reaped beautifully, laying the sheaves ready for tying, and not requiring instant tying, as it delivered them on one side; but the price charged for it was by far too much for us to recommend to farmers; but we highly commended it. Two men attended this machine.

Dray's (Hussey's) machine worked as it has done for two or three years past, but the sheaves must be instantly tied to prepare the way for its returning. Two men are requisite.

We must here observe that the three machines to which we have awarded prizes are capable of cutting all sorts of corn, while those of Messrs. Dray are only strictly speaking "reaping machines;" and while the present system, so largely practised by farmers, of growing seeds with their barley crops continues, on those farms Messrs. Dray's machines are not of general utility; but we allow that where the reaping of wheat only is an object, and if cut when fit for immediate tying, Messrs. Dray's are excellent machines, and their "Hussey" is cheap in comparison with all the others.

On referring to the Report of the trials at Leigh Court, in 1855, we feel perfectly justified in reversing the decision arrived at last year at Boxted Lodge, where there was evidently a great fault in the construction of the machine shown there by Messrs. Burgess and Key (and which fault lost them the First Prize), but which is now rectified by the addition of the spiral screw. We quite agree with the distinction made at Boxted between mowing and reaping machines. We wish therefore that the public should fully understand that for general harvest purposes we most highly approve of those machines to which we have now given prizes, each having a side delivery, and commend the machines of Messrs. Dray for reaping only.

We conclude by saying, that we think any further remarks needless; for to give every description of the above machines would be only to repeat the excellent Report of the Judges who attended at Leigh Court.

H. B. Caldwell.	J. J. Rowley.
W. Owen.	W. Chalcraft.
F. King.	C. S. Read.
J. Druce.	J. Clarke.

Awards of Prizes.

Messrs. Burgess and Key	£10 0 0
Mr. Crosskill	6 0 0
Lord Kinnaird	4 0 0
Messrs. Dray (Palmer's)	Highly commended.
Messrs. Burgess and Key	Highly commended.
Messrs. Dray (Hussey)	Commended.

Steam Cultivators.

To enter upon this subject with any degree of sufficiency, or to write a satisfactory account of the advance made by steam cultivators during the past year, is quite impossible.

At Salisbury we had four competitors, viz., Mr. Fowler, Mr. Boydell, Mr. Collinson Hall, and Mr. J. A. Williams. The Judges decided that on the morning they were to begin working, they should give notice of being ready: they were then to start from the yard as from the homestead of a farm, and from that time notes were to be taken of all their proceedings. In only *one* case was this carried out, and that was Mr. Boydell, who most triumphantly ascended the hill to the ground laid out for ploughing, and fully proved his power as a traction engine. He shortly commenced ploughing, but this was not satisfactory, for nothing could keep the ploughs in the ground. The work

he completed in breaking up the soil with Coleman's large cultivator was excellent, but this of course does not comply with the rule for the prize.

Mr. Collinson Hall's engine was unable, through an accident in making a sharp turn, to reach the field in time for the trial. His efforts to do so, in spite of this drawback, were strenuous and laudable, and he succeeded eventually in bringing up his engine and making good work.

Mr. J. A. Williams's system was anything but satisfactory in its results. The Judges regret to be compelled to add that the extreme discourtesy of his language and conduct towards themselves rendered their duties in the inspection of his work painful and unpleasant in a manner they never before had occasion to experience at the meetings of the Society.

Mr. Fowler, after much delay, began ploughing; the work done was very good, but here we must say we could not reduce the price per acre below that of the Boxted trials. As far as ploughing is concerned we think Mr. Fowler's arrangement of his ploughs is the best we have seen.

As Judges we wanted very strict data to recommend the steam ploughing to the public: we are sorry we cannot do this, though we think Mr. Fowler still stands pre-eminent over any others. We cannot say that his ploughs are "economical substitutes for the plough or the spade," neither do we think the wording of the premium can ever justify a judge in giving the prize while a plough is used.

Considering the great ability shown, and the great expense incurred, by Mr. Fowler to bring steam cultivation to a good result, we venture to recommend the Council of the Royal Agricultural Society to vote him a medal, as a reward for his strenuous endeavours in a good cause.

Signed H. B. CALDWELL,
WM. CHALCRAFT,
CLARE SEWELL READ,
J. DRUCE,
FIELDER KING.

The following Report by Messrs. Owen and Clarke, sent in previously to that of the other judges, will be read with interest, as offering some further particulars of the steam ploughing:—

As we have not yet been called upon in our collective capacity, we offer a few remarks on the trial of steam ploughs. The ground was altogether unsuitable. The soil was very shallow and unusually flinty, and the summer's drought had so hardened it that it was with great difficulty that the ploughs in the upper part of the field could be made to enter it at all. The site also of the field, upon a hill of considerable elevation, occasioned great difficulties and delay, except to Mr. Boydell's engine, which ascended it easily. The competitors actually in the field were Mr. Boydell, who brought his traction engine with a set of ploughs made by Burrell and Co. of Thetford; Mr. Collinson Hall, who brought a traction engine of similar character to Boydell's, but much smaller and of very dissimilar construction, and used Fowler's ploughs; Mr. Fowler, who brought two engines, one to be stationed at each end of his work, the ploughing to proceed between them; he, however, preferred using his anchorage; Mr. Williams, who also brought two engines, the ploughing to be between. His set of ploughs were in a triangular frame, each hanging independently, and guided in part by *a horse walking in shafts ahead*, and for the purpose of turning the frame round at the headlands. Mr. Coleman brought a large scarifier, capable of being worked by any engine. The work being across the top of the hill, the stationary engines, where *two* were used, could not be seen each from the other—an untoward circumstance for the double-engine system. However, the four allotted spaces being set out, the object to be accomplished was a *more economical mode of ploughing*

than could be done by horse-power. For ourselves, we were at once convinced that no satisfactory decision could be arrived at. The minor arrangements were fair. The coal was weighed; the time measured; but it was soon apparent that all would be of little avail. Mr. Boydell and Mr. Fowler certainly set to work in right good earnest and in a workmanlike manner. Mr. Boydell's ploughs could not take sufficient depth, and his ploughmen were unaccustomed to the work, consequently it was somewhat irregular, but sufficient was shown to convince us that Mr. Boydell's engine is one of no ordinary merit, and capable of very useful and extensive farm service. It drew Coleman's immense scarifier with ease, taking a great breadth and depth of soil which it completely broke up. Mr. Fowler alone continued in work till his plot was done, and his plough performed its work very creditably under all the circumstances of a hard soil and much obstructing company. The ploughing was effected in truly husbandlike manner, and at a depth not generally reached on such soils. The work was fairly laid and worthy of comparison with that done alongside it by one of Howard's ploughs in the hands of a first-rate ploughman. Mr. Williams, after considerable delay, proceeded; his ploughs could not be made to enter at the requisite depth; in vain he and his friends rode upon them and added weights; they could not be kept in, and therefore the work was not well done. The advantage which Mr. Williams possesses in being able to plough into "lands" is good. Mr. Fowler's is a "one-way plough." Mr. Boydell ploughs in every way required. Mr. Collinson Hall, having been seriously delayed by unavoidable and vexatious accidents, borne with remarkable spirit and good temper, ploughed a few bouts to show his capability, which is great, and the compact form and most ingenious adaptation of his engine met our approval. We make these few observations chiefly with the view of showing that this trial of steam-ploughing could not be a decisive nor a satisfactory one owing to the circumstances pointed out. We think that sufficient power and adaptation to accomplish steam-ploughing in an efficient and economical manner has been shown us; and that a proper time and suitable soil are only needed to prove it. We would, therefore, respectfully suggest that some time should be appointed, in the months of March or April next, and some rather strong loam selected for the trial.

William Owen.
John Clarke.

Miscellaneous Articles.

Neither of the undersigned had before been appointed to adjudicate in the Miscellaneous department. It is no easy task to roam through those 150 stands and discover every useful novelty and every deserving improvement. As it was we inspected upwards of 200 miscellaneous articles, and yet we fear there were some excellent inventions which may have escaped our notice. To the best of our limited knowledge, which, we would observe, has its centre in arable agriculture, we selected a quantity of the most useful and novel articles, and awarded to them the distinctions of medals, high and ordinary commendations. To be anything like an able judge of this department one ought to possess the deep and varied knowledge of King Solomon. There were machines of all sorts and sizes; from the ponderous proportions of a 6-horse power bone-mill to the tiny dimensions of a sausage-maker; and from the purely agricultural potato digger to the essentially domestic washing-machine and mangle. We were much aided in making our awards by the able assistance of the Society's engineers, which was readily and courteously rendered. We also eagerly received some useful hints from a lady whose thorough knowledge of domestic economy constituted her a much abler judge of certain in-door articles than we were. It would be impossible to notice even in the most casual way the

whole of the articles that we inspected; it would extend this report to greater length than most readers will approve, to say more than a few words on those we selected for honorary distinctions. First then, as to the medals.

Cottam and Cottam's Iron Collar-bar Hurdles.—Any one who has had much to do with iron fencing must have discovered that the middle standard in the hurdles is constantly shifting. This unsteadiness tends to weaken the fence and spoil its uniform look. Messrs. Cottam have applied a simple and effectual remedy. They have welded a small collar of iron on the bars of the hurdles; the collars are placed on alternate sides of the standards, which thus become tightly fixed. The iron fencing is thus considerably strengthened without any detraction from its light appearance, and, what is of more consequence, without any extra cost to the purchasers.

Perreaux and Co.'s Vulcanised India-rubber Pump Valve.—We are indebted to M. L. C. Perreaux, of Paris, for this clever invention. Liquid manure pumps are constantly out of sorts; the acids of the manure speedily destroying the best leather valve, and the pump often stops from straws or other substances that stick in the valves. It appears probable that vulcanised India-rubber will resist the destructive influence of the manures, and from its flexibility it is impossible to choke it. A small pump in the Salisbury yard readily took up corks, large rags, and other such things; and what is more wonderful, still threw up a steady stream of water. Any description of this invention, without an illustration, would be hard to comprehend, and for further particulars we must refer to the description given in the prize list of the last Journal.

Messrs. Hill and Smith's wrought-iron Sheep Trough we considered worthy of a medal. It was well and substantially made, yet light and portable, being mounted on four wheels. The sheep cannot throw out any food, or easily upset the trough, and a rail prevents them jumping over or getting into it. It was 9 feet long, and cost 30*s*. It would answer well for water in summer, and, with a coat of tar now and then, would last a great number of years. We may here observe that we highly commended a water trough of Mr. Gripper, and commended the cheap and durable wrought-iron cattle troughs exhibited by Messrs. Burney and Bellamy.

Mr. Carson, of Warminster, showed a compact and excellent *Cheese Press.* It was well manufactured, and a great pressure is obtained for large cheeses by the weight being suspended from a compound lever over a pulley; by this means the simple weight produces a double pressure. The price was reasonable, 55*s*.

Messrs. Cockey and Sons had a very complete *Cheese-making Apparatus.* We are not practically acquainted with extensive cheese-making, but heard from some gentlemen who had used the apparatus, that a great saving was effected, and better cheese produced. The whole arrangements seemed grounded on scientific and economical principles.

The only competitive trial in the miscellaneous department was among the churns. Three small churns contested for the medal which we had to award in that class. Each churn was furnished with a little more than 2 quarts of average cream, and the following is the result of the trial:—

Owner's Name.	Stand.	Number.	Time in which Butter was produced.	Quantity.		Quality.
			Minutes.	lbs.	oz.	
Ferryman	21	2	10	2	6	Very good.
Weir	76	8	11½	2	2	Ordinary.
Johnstone	119	6	11½	2	5	Good.

The medal was awarded to the Rev. E. A. Ferryman. The principal feature in this churn is that the beaters thoroughly press or knead out the buttermilk, thus rendering it less likely to turn rancid, and in a measure superseding the necessity of handling it. These are great desiderata, especially in hot weather. The butter produced was of first-rate quality, but the churn was not very nicely made, as a good deal of cream sprayed out from under the lid. Mr. Johnstone's churn produced good butter, was neatly manufactured, easily cleaned, and in every respect well earned its high commendation. We could not say much for the American Hydro-Thermal churn. It produced less butter than the other two, and that of a very inferior description. It is furnished with hollow metal beaters, to be filled with hot or cold water to raise or lower the temperature of the cream. This is an ingenious contrivance, but we prefer a churn whose interior is composed entirely of wood.

Hanson's *Potato-Digger*, exhibited by Mr. Coleman, must be a very useful implement where a large breadth of potatoes is grown and labour is scarce. A great share, something like a shovel, passes under the row of tubers, while a set of revolving forks throws them on the surface.

We now come to the High Commendations. Foremost we must mention the *American platform beehive* which will form a useful and interesting addition to every apiary. This contained a lively swarm of bees, and was thus exhibited in full work. The various contrivances for removing the honey, transferring the bees, feeding them in cold weather, and removing the filth, seemed to us to fully merit a high commendation, which was all we could do for it, our medals being distributed among articles more closely connected with agriculture.

That fruitful land of invention (America) furnished us with another subject for high commendation in its *floating-ball washing-machine*. It appears calculated to save labour, and it cleaned some very dirty collars in less than a minute, and does not appear liable to tear or damage the linen. This machine was shown by Mr. Weir.

Mr. Richards' *circular-pointed cooking ranges* present a large available space for all culinary operations. Everything was well planned with regard to convenience and economy, and the whole appeared well made and reasonable in price.

Mr. John James exhibited a very useful *weighing machine* for roots and potatoes. It can be easily removed and planted in the field, and its scoop-shaped scale makes it easy to fill and empty.

The *force and lift pump* of Messrs. Burgess and Key is to us quite a novelty. America again. The pump is composed of an India-rubber tube, and by the external pressure of a roller and its own elasticity, dispenses with all valves and boxes. It sent out a strong stream of water, but how long the tube will resist the friction of the roller remains to be proved.

Messrs. Cottam and Hallam showed a splendid assortment of *stable fittings*. They were of the most useful description, elegantly designed, and the workmanship was faultless.

The *iron tubular 4-horse whipple-trees* of Messrs. Howard can be attached with advantage to Biddle's and Coleman's large scarifiers. The horses all draw from the same middle chain, which passes round a pulley; this tends to equalize the draught among the four horses.

The *iron wire sheep-fold fence* of Messrs. Greening was cheap and excellent. It can be very easily fixed, and was well coated with a bright and durable-looking varnish.

Mr. Stanley's *barrow and sack raiser* acted well, and must be a useful adjunct to steam-threshing. It is rather dear, the price being 3*l.* 10*s.*

The *cast-iron tap* of Barnard and Bishop is simple, and the best we know for common water carts. In a moment it shuts off the stream of water; there

is no screwing or turning the tap, and there is nothing that can soon get out of order. There are some parts that would be better made of wrought iron than cast.

The *collection of seeds and roots* of Messrs. T. Gibbs and Co. was in itself quite a show. It was well worthy a minute inspection, and we regretted we could not bestow on it more than a hurried glance. The wax specimens of roots were artistically and truthfully executed, and the specimens of grain remarkably fine and neatly arranged. Messrs. Lawson and Son had a very excellent exhibition, which was only second to the stand of the Seedsman to the Royal Agricultural Society.

The Commendations in our class included the following:—The *hydraulic and veterinary instruments* of Mr. R. Read, of Regent's Circus, exhibited the most perfect workmanship. The watering engines may be regarded as belonging to the garden rather than the farm, but we have known them of essential service at a fire. At the commencement of conflagrations they have saved a vast amount of property, and the farmer who purchases one for his garden may find it of great utility, should his premises be unfortunately visited by fire.

Mr. Powell showed a clever little *hand bean-dibble*, and a sort of *Dutch-hoe*, which, as it cuts both ways, was described as a *draw-share hoe*. We much question the statement in the catalogue that a man could hoe upwards of an acre per day with this hoe; he must walk at a furious rate, or work extra hours.

The stall of Messrs. Cottam, with a *swinging manger*, seemed a good contrivance for a crib-biting horse. As soon as the corn is eaten the manger shuts back, and there is nothing left for the horse to bite.

The *asphalting apparatus*, shown by Mr. Woods, is capital for the purpose of laying down these very useful floors. By a space being left under the copper and round the furnace, the sand can be dried before being mixed with the asphalte. This saves a great deal of fuel.

At Carlisle we first saw Mr. Lister's implement for *tailing turnips in the land*. It is well adapted for cutting off the roots of turnips as they stand, but still 6*l.* 10*s.* is a large sum for an implement which could not be used many days in the year. We have seen good shift made with a double horse-hoe. Something of the kind is often needed, especially in seasons when the fibrous roots are numerous and strong. The frame of Mr. Lister's machine (which was at Mr. Busby's stand) is strong enough to serve for a light scarifier or parer.

Messrs. Hill and Smith's *premium iron hurdles* are very good. They are made by machinery, of the best Staffordshire wrought iron when in a cold state.

Mr. Sym's little machine for *mincing meat and making sausages* is well and deservedly known. The *valve box* of Mr. Fowler's double-barrelled pump is very accessible, a most important feature in pumps. Messrs. Wallis and Haslam had a very useful *machine for drilling iron*, and in these days of cast-iron implements such a machine is often wanted. The engineers considered that the *American rotatory* 1-*horse power* of Messrs. Burgess and Key merited a commendation. Messrs. Howard's *oval stem of the plough-coulter* is supposed to be stronger than a round one: it at least presents a greater thickness of iron where most wanted, and is as easily altered as the round coulters. Mr. Crowley had a substantial set of *good iron hames*, and Mr. Thompson exhibited a handy *workman's draining bevel*. And there was Mr. Biggs' *cradle for sheep-dipping*, and Mr. Athawe's *percolator forks*, and Messrs. Ransome's *stable box-fittings*, all useful in their way and worthy of notice.

These we believe were the articles in the miscellaneous department which presented the chief features of excellence and novelty. We again repeat that it is no easy task, on being turned loose into a yard containing so many articles, to select the best and most perfect specimens of its miscellanea. Useful and ornamental objects abounded throughout the show; some so well

established and appreciated that we thought an honorary notice superfluous. Such were Messrs. Dray and Co.'s circular iron corn bins, and their strong and cheap field gates. Other articles again seemed more calculated for a fine-arts exhibition than an agricultural show; prominent among such we would name Mr. Johnson's elegant garden seats and ornamental flower stands. Then there were one or two intricate and funny contrivances, the ins and outs of which we could not understand; it might be ignorance, but we thought their ingenuity only surpassed by their uselessness.

In concluding our remarks on this department we think it would facilitate the operations of future Judges if *what is a miscellaneous article* was more clearly defined. We were told that anything not essentially an agricultural implement was a miscellaneous article. If so, half the show would belong to this class. It would have lightened our responsibilities and lessened our labours if the Society had published some definite instructions on this point.

WM. CHALCRAFT,
CLARE SEWELL READ.

XVII.—*On Road-mending*. By the Hon. W. G. CAVENDISH, M.P.

[The following letter and plan, sent to me by Mr. Cavendish, on the subject of mending roads, need no apology for their insertion. The system is excellent. It is already to some extent adopted in the neighbourhood of London, but rarely in country or on farm roads. It is a very simple, and, as far as I know, the only preservative against the immediate formation of fresh ruts on roads newly stoned.—C. W. H.]

I SEND you one of the plans of road-making that I spoke to you about. Mr. Robert Arkwright, of Sutton, gave it to me, and, I think, from seeing some miles of road that he has had repaired about his house in Derbyshire, the principle is a good one, and I should be glad if it were more generally adopted. If you should think it worth a place in the Journal, it is much at your service.

When I was last in Derbyshire I had some conversation with Mr. Arkwright upon the method. He introduced, and has now adopted it for some years with the greatest success upon all the roads in his neighbourhood. It was not without much trouble at first that he succeeded in persuading the surveyor or mender of the roads that it was better to lay the stones *partially* over the road, instead of the old system of covering *the whole* of the road with them, in which case they were sure to be worn into ruts.

If the surveyor, or mender, of roads has a little common sense, a quick eye, and is anxious to improve the very imperfect method now adopted in repairing roads, very few hints will suffice to

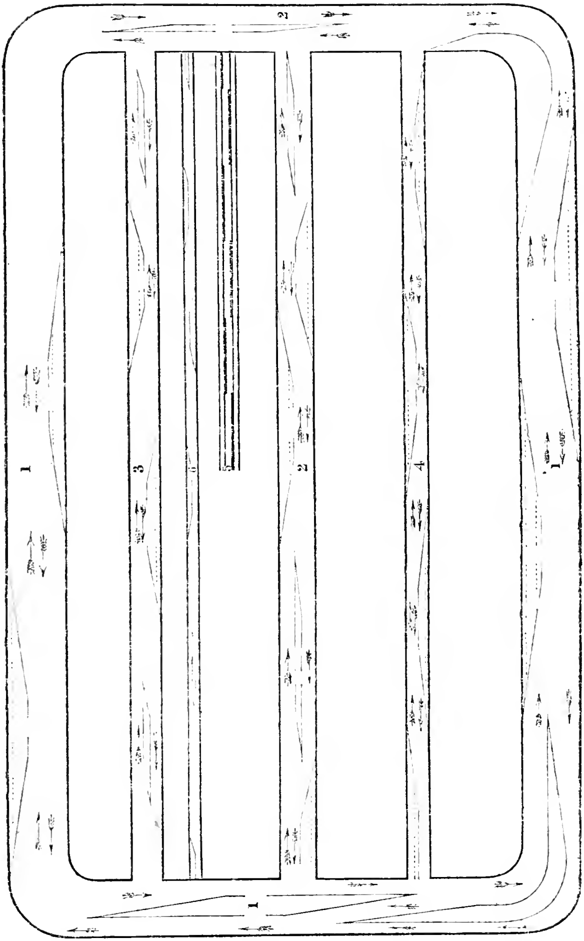
explain the annexed diagram. This plan cannot be carried out without some trouble and perseverance, and few surveyors can spare time from their other engagements to carry it out. Of course the exact shape need not be adopted; that must depend upon the state of the road, as to form, length, and width, and the quantity of materials necessary to be put on at the time. A passage free from stones must always be left; every patch to taper at each end, so shaped as to induce the horses to travel by the (near or left) side of the newly-mended road, and not through it, tearing up with their feet those stones that have been pressed together by carriage-wheels having passed over them. When it is necessary to mend the road in very small patches, care must be taken to have a serpentine road free from any stones. I need hardly say that the part where the stones are to be laid ought to be picked up, and the stones *broken small enough*, before they are laid on the road.

WILLIAM G. CAVENDISH.

Latimer, 1857.

		Nos. on Diagram.					
		1.	2.	3.	4.	5.	6.
Whole width of road		30 ft.	21 ft.	15 ft.	12 ft.	10 ft.	As No. 1.
Middle repair	Width not to exceed	10 ,,	5 ,,	3 ,,	2 ,,		
	Length not to exceed	40 yds.	30 yds.	20 yds.	10 yds.		
	To taper, length not less than	40 ft.	20 ft.	12 ft.	8 ft.		
	Smooth road left on each side, width not less than	10 ,,	8 ,,	6 ,,	5 ,,		
Side repair	Width not to exceed	10 ,,	8 ,,	6 ,,	5 ,,		
	Length not to exceed	40 yds.	30 yds.	20 yds.	10 yds.		
	To taper, length not less than	40 ft.	20 ft.	12 ft.	8 ft.		
	Smooth road left on one side, not less than	20 ,,	13 ,,	9 ,,	7 ,,		

N.B.—When a road is worn into ruts, repair *one* of them for some yards; the other to be repaired when the first layer is partially worn.



XVIII.—*Agricultural Chemistry.—On the Growth of Barley by different Manures, continuously on the same Land; and on the position of the Crop in Rotation.* By J. B. Lawes, F.R.S., F.C.S., and Dr. J. H. Gilbert, F.C.S.

In endeavouring in former Papers in this Journal to convey such an idea as existing knowledge permitted, of the chemical facts and principles which our *Rotation of Crops* involves, we have supported the views put forth, by carefully ascertained data regarding the individual elements which constitute that important practice. The subjects which necessarily pass under review in such an inquiry are, the characteristic requirements of growth of—

1st. The Root Crops,
2nd. The saleable Cereal Grains,
3rd. The Leguminous Corn and Fodder Crops;

and lastly, the chemical circumstances involved in—

4th. The consumption of food by stock on the farm.

In regard to some of these branches, only the general conclusions drawn from the evidence accumulated have been given; whilst on others, a good deal of the evidence upon which the conclusions have been founded, has been laid in detail before the reader.

Thus, with regard to the *Cereals*, the reader is already in possession of a considerable portion of the results of the experiments in the *field* * relating to the growth of *wheat;* and before adding to the registry on that head, it seems desirable to put on record something relating to *barley*—the next in importance to wheat in the class of the saleable cereal grains of our rotations.

We have always assumed that barley, apart from local and minor distinctions, was closely allied to wheat in certain characteristic chemical requirements of its growth. Independently of common observation, the direct evidence upon which this opinion was founded, was a course of field experiments on barley, conducted in 1845. At that time about ten acres were appropriated to the investigation, which it was intended should be continued through a considerable series of years. Owing, however, to the great labour and attention required in following up experiments of this kind, both in field and laboratory, with sufficient accuracy and detail to serve a scientific purpose, it was decided to rest satisfied with the first year's clear indications in the field, until other branches of the main inquiry, then occupying all our available time, should be somewhat further forwarded.

* For the results in the laboratory, showing the influence of circumstances of growth on the *composition* of wheat, see 'Journal of the Chemical Society,' vol. x., part i., p. 1–55: 'On some points in the Composition of Wheat-Grain, its Products in the Mill, and Bread.'

Systematic experiments with barley grown by different manures were resumed in 1852. It is the field results of these from that time to the present, together with some gleanings from the laboratory relating to them, and also the records of collateral experiments on the crop grown under certain other known conditions of manuring and cropping, and in rotation, that will form the subject of the present Paper. On this plan our tabulated matter will be necessarily very voluminous. It would be undesirable, therefore, to encumber our statement with a detailed account of the earlier series of experiments, especially as the later ones, though not quite so comprehensive, are somewhat better arranged for showing up the points of interest. It will suffice to say then, of the earlier experiments, that their results were consistent with those of the later, which are now to be examined.

The land set apart in 1852 for the continuous growth of barley by different manures was in the adjoining field to that devoted to the continuous growth of wheat, and its general character was very similar to that of the latter. It had grown clover in 1849, wheat in 1850, and in 1851 barley, dressed with sulphate of ammonia. It was, therefore, in an agricultural point of view, in a somewhat exhausted condition so far as the aftergrowth of grain was concerned, and it was hence in a suitable state for testing the effects of different manures upon the barley crop. The area of land appropriated was about five acres, divided into nearly square plots of about one-fifth of an acre each. In order to distinguish this set of experiments from those afterwards to be noticed, it will be convenient to give the field in which it was made its usual name, namely, Hoos-field.

The description and quantities of the different manures are given as fully as space will permit, in the Tables, by the side of the results they yielded. To the statements there given one or two explanations will be necessary.

It should be mentioned, that there were two plots unmanured, one at either side of the experimental land; and it is the mean result of these that is given as Experiment No. 1.

The clay and weed-ashes employed in Experiment No. 2, were of the same description as those mixed in smaller quantity with the other manures to aid their easy distribution over the land.

The farmyard manure, was only from the open yard, and did not contain the dung of animals highly fed on artificial food.

The so-called "*Mixed Alkalies*," comprised, per acre—

300 lbs. sulphate of potash,
200 lbs. sulphate of soda,
100 lbs. sulphate of magnesia.

The "*Superphosphate of Lime*," was composed (per acre) of—

200 lbs. calcined bone-dust,
150 lbs. sulphuric acid (sp. gr. 1·7).

The "*Mixed Minerals*," consisted of both the "Mixed Alkalies" and the "Superphosphate of Lime," as above described.

All the artificial manures, after being well mixed with clay and weed-ashes up to a given measure, were carefully sown by *hand;* for, though the drill is undoubtedly by far the best means of getting an average distribution of manure over large areas of land, the experience of our wheat experiments has taught us that there is danger of some irregularity when applied only to small ones, where accuracy, one compared with another, is essential. The manures being sown, they were ploughed in very shallow.

The seed, which was the Chevallier, was however always *drilled*—$2\frac{1}{2}$ bushels per acre in 1852 and 1853, and 7 pecks per acre in 1854-5-6 and 7.

The results obtained during the six years' continuance of the experiments are given in Tables as follows:—

Table I.—Dressed Corn per Acre, in bushels and pecks.

Table II.—Total Corn per Acre, lbs.

Table III.—Total Straw and Chaff per Acre, lbs.

Table IV.—Total Produce (Corn and Straw together) per Acre, lbs.

Table V.—Proportion of Total Corn, in 100 Total Produce.

Table VI.—Proportion of Dressed Corn, in 100 Total Corn.

Table VII.—Weight per Bushel of Dressed Corn, lbs. and tenths.

Table VIII. is a summary of Tables I. to VII. inclusive. It gives, for each separate year, the seven characters of crop which the former Tables respectively record, but for the *mean only* of five classes, into which the series of individual experiments are here arranged. This Table affords, therefore, at one view a comparison of the effects of the individual *seasons* (both upon the quantity and quality of the produce); and each under the influence of five distinct classes of manures.

Table IX. is a summary of another kind. It gives for each of the twenty individual manures its *average annual* effect, taken over six years, on each of the characters of quality and quantity of the produce. In this Table, therefore, instead of comparing the influence of the individual *seasons*, we compare that of the individual *manures*, taking for each the mean result of six years' trial. (For the Tables I.-IX. inclusive, see pp. 458-475.)

It would be only irksome to the reader, and perhaps even confusing, were we to give a running and detailed comment upon the numerous figures recorded in Tables I. to VII. They are, however, deserving a careful examination, which cannot fail usefully to fix on the mind the clear idea which actually recorded facts conveys, of how really great are the fluctuations in the results of the farmer's efforts and outlays, due to the ever-changing seasons. Such a study would at the same time show, that, however great the uncertainty as to the actual amounts of produce to be calculated upon, depending upon climatic vicissitudes, there is still, even with these, on some points a considerable degree of uniformity and certainty in the relative results of certain characteristic classes of manures. In the comments which follow we shall confine attention chiefly to the Summary Tables VIII. and IX. In doing so we shall perhaps be able to convey a sufficient idea of the prominent results to the casual reader, and at the same time usefully to guide the further examination of the more careful one.

It would have been a useful introduction to the consideration of the actual variations of result obtained in the field in the different seasons, to have taken a comparative view in some detail, of the climatic conditions themselves of the six seasons under which the varying results have been obtained. With the view of doing this, numerous tables have been arranged, bringing together in much detail the actual climatic statistics of the several seasons; and also others, showing the indices or relative order, comparing season with season, of the actual characters so registered. From the large amount of tabular matter, and the space required for its consideration, which the more proper subject matter of the paper—the effects of different manures on the barley crop—itself involves, we are obliged to forego this part of our plan. A few general observations must suffice therefore, on this intimately associated collateral branch of the subject. When, however, it is considered, that the different seasons will vary almost infinitely in relation to one another in their favourable adaptations at each succeeding period of their advance, and that with these variations must vary as constantly the tendency of development of the plant for quantity or for quality, it will be obvious, that it is only a very detailed consideration of climatic statistics, taken together with careful coincident observation in the field, that can afford a really clear perception of the connection of the ever fluctuating characters of season, with the equally fluctuating characters of result. It is in fact the distribution, and the mutual adaptations, of the many characters making up the season, in their relation to the stage of growth of the plant, which give the resultant impress, for quantity or for quality, upon its progress.

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RESULTS of EXPERIMENTS on the GROWTH of BARLEY by different MANURES:—made (Hoos-Field,

TABLE I.—DRESSED CORN per

Experiments.	MANURES. (Quantities per Acre, per Annum).	ANNUAL 1852. bush.	1852. pks.	1853. bush.	1853. pks.	1854. bush.	1854. pks.	1855. bush.	1855. pks.
	SERIES 1.—Gauge, or								
1	No Manure	27	3½	26	0¾	35	0¾	33	1¾
2	20 bushels Clay and Weed Ashes	25	0½	27	1¼	33	1¼	36	1
	Mean	26	2	26	3	34	1	34	3¼
3	14 tons Farmyard Manure	33	0	36	0¾	56	1½	50	0¾
	SERIES 2.—With								
4	Mixed Alkalies (Sulphates of Potash, Soda, and Magnesia)	26	0¾	27	2¼	36	2	34	3
5	Superphosphate of Lime	28	2½	33	2¼	40	2¾	36	1
6	Superphosphate of Lime, and "Mixed Alkalies"	32	3	35	2¼	42	0	37	0¼
	Mean	29	0¾	32	1	39	3	36	0¼
	SERIES 3.—With Nitrogen per acre, equal to about 50 lbs.								
7	275 lbs. Nitrate of Soda, alone	*		34	1½	49	1¼	50	0
8	100 lbs. each, Sulphate and Muriate of Ammonia, alone	36	3½	38	2¾	47	3¼	44	2
9	100 lbs. each, Sulphate and Muriate of Ammonia, and "Mixed Akalies"	36	0¼	36	2¼	50	0	44	2¼
10	100 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime	38	2½	40	0½	60	2¼	47	3¼
11	100 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime, and "Mixed Alkalies"	40	3¼	38	1¼	60	2¾	48	1½
	Mean	38	0¼	37	2½	53	2¾	47	0¼
	SERIES 4.—With Nitrogen per acre, equal to about 100 lbs.								
12	550 lbs. Nitrate of Soda, alone	*		37	0½	53	1	49	1¼
13	200 lbs. each, Sulphate and Muriate of Ammonia, alone	44	2	40	3	56	2¼	48	0¼
14	2000 lbs. Rape Cake, alone	39	0½	39	3¾	60	3	48	2
15	200 lbs. each, Sulphate and Muriate of Ammonia, and "Mixed Alkalies"	41	3¼	41	1¼	51	2¼	47	1¼
16	200 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime	43	3	42	1	63	1	50	1¾
17	200 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime, and "Mixed Alkalies."	45	0¾	44	2	62	3	49	2¾
18	2000 lbs. Rape Cake, and "Mixed Alkalies"	33	2	35	1	56	2	48	3¾
19	2000 lbs. Rape Cake, and Superphosphate of Lime	36	2	36	0¾	60	2¾	53	1
20	2000 lbs. Rape Cake, and Superphosphate of Lime, and "Mixed Alkalies"	38	0	40	0¾	60	1	51	3
	Mean	40	1¼	39	3	58	1½	49	2¾

* No Nitrate of Soda in 1852; but Sulphate of Potass, and Superphosphate of Lime.

during six consecutive Years on the same Land—1852, 53, 54, 55, 56, and 1857. Rothamsted, Herts.)

Acre—in Bushels and Pecks.

Produce. 1856.		Produce. 1857.		Total (6 years).		Average Annual.		Average Annual Increase by Manure. Bushels.		With what Standard compared.
Standard Series.										
bush.	pks.	bush.	pks.	bush.	pks.	bush.	pks.			
14	1¼	29	1¾	166	1¾	27	3			
15	3¼	31	0¼	169	0½	28	0¾			
15	0½	30	1¼	167	3¼	28	0			
32	0¾	51	1¼	259	1	43	0¾	15	0¾	Over Unmanured.
Mineral Manures only.										
16	2½	32	0	173	2¾	28	3¾	0	3¼	Over Unmanured.
17	3½	33	1	190	0¾	31	2¾	3	2¼	Over Unmanured.
19	3	39	3¼	207	0½	34	2	6	2	Over Unmanured.
18	0½	35	0	190	1¼	31	2¾	3	2¼	Over Unmanured.
Ammonia; both without and with direct Mineral Manures.										
28	2¼	47	3¾	†210	1	†42	0¼	14	0¼	Over Unmanured.
25	0	38	3¾	231	3¼	38	2½	10	2½	Over Unmanured.
28	1¾	42	1¾	238	0¼	39	2¾	10	3	Over "Mixed Alkalies" (No. 4).
29	0½	56	2¼	272	3¼	45	2½	13	3¾	Over Superphosphate of Lime (No. 5).
31	3	57	1¾	277	1¼	46	1	11	3	Over Superphosphate of Lime, and "Mixed Alkalies" (No. 6).
28	2¼	48	2¾	253	2¾	42	2	10	3¼	Over Mean of Mineral Series.
Ammonia; both without and with direct Mineral Manures.										
42	0	58	0	†239	3	†47	3¾	19	3¼	Over Unmanured.
36	1	49	3¼	276	0	46	0	18	0	Over Unmanured.
36	3¼	64	0½	289	1	48	0¾	20	0¾	Over Unmanured.
25	1½	49	3¾	257	1½	42	3½	13	3¾	Over "Mixed Alkalies" (No. 4).
31	2	66	2¼	297	3	49	2¼	17	3½	Over Superphosphate of Lime (No. 5).
37	2½	64	3½	304	2½	50	3	16	1	Over Superphosphate of Lime, and "Mixed Alkalies" (No. 6).
32	2½	60	1	267	0¼	44	2	15	2½	Over "Mixed Alkalies" (No. 4).
37	0½	62	1¼	286	0½	47	2¼	16	0	Over Superphosphate of Lime (No. 5).
35	1½	62	1	287	3¼	48	0	13	2	Over Superphosphate of Lime, and "Mixed Alkalies" (No. 6)
34	3¾	59	3¼	282	3½	47	0½	15	1¾	Over Mean of Mineral Series.

† Taken for 5 years only.

RESULTS of EXPERIMENTS on the GROWTH of BARLEY by different MANURES:—made (Hoos-Field,

TABLE II.—TOTAL CORN

Experiments.	MANURES. (Quantities per Acre, per Annum).	ANNUAL 1852.	1853.	1854.	1855.
	SERIES 1.—Gauge, or				
		lbs.	lbs.	lbs.	lbs.
1	No Manure	1600	1538	1976	1886
2	20 bushels Clay and Weed Ashes	1451	1555	1904	1982
	Mean	1526	1547	1940	1934
3	14 tons Farmyard Manure	1844	2136	3127	2765
	SERIES 2.—With				
4	Mixed Alkalies (Sulphates of Potash, Soda, and Magnesia)	1558	1586	2021	1918
5	Superphosphate of Lime	1605	1867	2298	1973
6	Superphosphate of Lime, and "Mixed Alkalies"	1819	2017	2374	2067
	Mean	1661	1823	2231	1986
	SERIES 3.—With Nitrogen per acre, equal to about 50 lbs.				
7	275 lbs. Nitrate of Soda, alone	*	2044	2740	2727
8	100 lbs. each, Sulphate and Muriate of Ammonia, alone	2088	2285	2763	2443
9	100 lbs. each, Sulphate and Muriate of Ammonia, and "Mixed Alkalies"	2091	2259	2897	2504
10	100 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime	2212	2352	3437	2639
11	100 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime, and "Mixed Alkalies"	2368	2509	3428	2659
	Mean	2190	2250	3053	2594
	SERIES 4.—With Nitrogen per acre, equal to about 100 lbs.				
12	550 lbs. Nitrate of Soda, alone	*	2071	3113	2696
13	200 lbs. each, Sulphate and Muriate of Ammonia, alone	2486	2394	3313	2640
14	2000 lbs. Rape Cake, alone	2193	2318	3368	2668
15	200 lbs. each, Sulphate and Muriate of Ammonia, and "Mixed Alkalies"	2431	2358	3075	2586
16	200 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime	2483	2435	3643	2707
17	200 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime, and "Mixed Alkalies"	2532	2590	3539	2582
18	2000 lbs. Rape Cake, and "Mixed Alkalies"	1907	2113	3221	2659
19	2000 lbs. Rape Cake, and Superphosphate of Lime	2057	2243	3444	2857
20	2000 lbs. Rape Cake, and Superphosphate of Lime, and "Mixed Alkalies"	2098	2302	3413	2783
	Mean	2273	2314	3350	2686

* No Nitrate of Soda in 1852; but Sulphate of Potass, and Superphosphate of Lime.

during six consecutive Years on the same Land—1852, 53, 54, 55, 56, and 1857. Rothamsted, Herts.)

per ACRE—in Lbs.

PRODUCE. 1856.	PRODUCE. 1857.	TOTAL (6 years).	Average Annual.	Average Annual Increase by Manure. Lbs.	With what Standard compared.
Standard Series.					
lbs. 849	lbs. 1620	lbs. 9,469	lbs. 1578		
923	1739	9,554	1592		
886	1679	9,512	1585		
1656	2915	14,443	2407	822	Over Unmanured.
Mineral Manures, only.					
936	1741	9,760	1627	42	Over Unmanured.
886	1861	10,490	1748	163	Over Unmanured.
1018	2191	11,486	1914	329	Over Unmanured.
947	1931	10,579	1763	178	Over Unmanured.
Ammonia; both without and with direct Mineral Manures.					
1675	2634	†11,820	†2364	779	Over Unmanured.
1432	2133	13,144	2191	606	Over Unmanured.
1577	2302	13,630	2272	645	Over "Mixed Alkalies" (No. 4).
1467	3161	15,268	2545	797	Over Superphosphate of Lime (No. 5).
1599	3216	15,579	2596	682	Over Superphosphate of Lime, and "Mixed Alkalies" (No. 6).
1550	2689	14,326	2394	631	Over Mean of Mineral Series.
Ammonia; both without and with direct Mineral Manures.					
2225	3226	†13,331	†2666	1081	Over Unmanured.
2061	2725	15,619	2603	1018	Over Unmanured.
1870	3547	15,984	2664	1079	Over Unmanured.
1489	2708	14,647	2441	814	Over "Mixed Alkalies" (No. 4).
1687	3696	16,651	2775	1027	Over Superphosphate of Lime (No. 5).
1886	3677	16,806	2801	687	Over Superphosphate of Lime, and "Mixed Alkalies" (No. 6).
1711	3417	15,028	2505	878	Over "Mixed Alkalies" (No. 4).
1916	3521	16,038	2673	925	Over Superphosphate of Lime (No. 5).
1841	3536	15,973	2662	748	Over Superphosphate of Lime, and "Mixed Alkalies" (No. 6).
1854	3339	15,816	2643	880	Over Mean of Mineral Series.

† Taken for 5 years only.

RESULTS of EXPERIMENTS on the GROWTH of BARLEY by different MANURES :—made (Hoos-Field,

TABLE III.—TOTAL STRAW and

Experi-ments.	MANURES. (Quantities per Acre, per Annum).	ANNUAL 1852.	1853.	1854.	1855.
					SERIES 1.—Gauge, or
		lbs.	lbs.	lbs.	lbs.
1	No Manure	1884	1950	2472	1993
2	20 bushels Clay and Weed Ashes	1579	1781	2317	1875
	Mean	1731	1865	2395	1934
3	14 tons Farmyard Manure	2076	2546	4171	3087
					SERIES 2.—With
4	Mixed Alkalies (Sulphates of Potash, Soda, and Magnesia)	1847	1935	2332	1955
5	Superphosphate of Lime	1854	1916	2600	1982
6	Superphosphate of Lime, and "Mixed Alkalies"	2189	2295	2595	2015
	Mean	1963	2049	2509	1984
	SERIES 3.—With Nitrogen per acre, equal to about 50 lbs.				
7	275 lbs. Nitrate of Soda, alone	*	2587	3735	3030
8	100 lbs. each, Sulphate and Muriate of Ammonia, alone	2564	2665	3392	2705
9	100 lbs. each, Sulphate and Muriate of Ammonia, and "Mixed Alkalies"	2639	2820	3775	3075
10	100 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime	2915	2850	4580	3290
11	100 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime, and "Mixed Alkalies"	3119	2975	4530	3475
	Mean	2809	2779	4002	3115
	SERIES 4.—With Nitrogen per acre, equal to about 100 lbs.				
12	550 lbs. Nitrate of Soda, alone	*	2835	4287	3720
13	200 lbs. each, Sulphate and Muriate of Ammonia, alone	3004	2930	4235	3602
14	2000 lbs. Rape Cake, alone	2756	3005	4850	4052
15	200 lbs. each, Sulphate and Muriate of Ammonia, and "Mixed Alkalies"	2947	3047	4240	3802
16	200 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime	3179	3180	4976	4320
17*	200 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime, and "Mixed Alkalies"	3182	3544	5487	4472
18	2000 lbs. Rape Cake, and "Mixed Alkalies"	2444	2830	4627	4017
19	2000 lbs. Rape Cake, and Superphosphate of Lime	2656	2867	4944	4047
20	2000 lbs. Rape Cake, and Superphosphate of Lime, and "Mixed Alkalies"	2698	3084	4712	4210
	Mean	2858	3036	4706	4027

* No Nitrate of Soda in 1852; but Sulphate of Potass, and Superphosphate of Lime.

during six consecutive Years on the same Land—1852, 53, 54, 55, 56, and 1857. Rothamsted, Herts.)

CHAFF per ACRE—in Lbs.

PRODUCE. 1856.	PRODUCE. 1857.	TOTAL (6 years).	Average Annual.	Average Annual Increase by Manure. Lbs.	With what Standard compared.
Standard Series.					
lbs. 1006	lbs. 1570	lbs. 10,875	lbs. 1812		
1058	1637	10,247	1708		
1032	1604	10,561	1760		
2210	2649	16,739	2790	1030	Over Unmanured.
Mineral Manures, only.					
1025	1685	10,779	1796	36	Over Unmanured.
979	1745	11,076	1846	86	Over Unmanured.
1057	1920	12,071	2012	252	Over Unmanured.
1020	1783	11,309	1885	125	Over Unmanured.
Ammonia; both without and with direct Mineral Manures.					
2202	2755	†14,309	†2862	1102	Over Unmanured.
1915	1985	15,226	2538	778	Over Unmanured.
1997	2400	16,706	2784	988	Over "Mixed Alkalies" (No. 4).
2407	3000	19,042	3174	1328	Over Superphosphate of Lime (No. 5).
2382	3120	19,601	3267	1255	Over Superphosphate of Lime, and "Mixed Alkalies" (No. 6).
2181	2652	17,538	2925	1040	Over Mean of Mineral Series.
Ammonia; both without and with direct Mineral Manures.					
3225	3590	†17,657	†3532	1772	Over Unmanured.
2740	2635	19,146	3191	1431	Over Unmanured.
2910	3715	21,288	3548	1788	Over Unmanured.
2925	2910	19,871	3312	1516	Over "Mixed Alkalies" (No. 4).
3546	3687	22,888	3815	1969	Over Superphosphate of Lime (No. 5).
3696	4057	24,438	4073	2061	Over Superphosphate of Lime, and "Mixed Alkalies" (No. 6).
2962	3460	20,340	3390	1594	Over "Mixed Alkalies" (No. 4).
3531	3745	21,790	3632	1786	Over Superphosphate of Lime (No. 5).
3416	3705	21,825	3638	1626	Over Superphosphate of Lime, and "Mixed Alkalies (No. 6).
3217	3500	21,344	3570	1685	Over Mean of Mineral Series.

† Taken for 5 years only.

RESULTS of EXPERIMENTS on the GROWTH of BARLEY by different MANURES:—made (Hoos-Field,

TABLE IV.—TOTAL PRODUCE (CORN

Experiments.	MANURES. (Quantities per Acre, per Annum.)	ANNUAL			
		1852.	1853.	1854.	1855.
		SERIES 1.—Gauge, or			
		lbs.	lbs.	lbs.	lbs.
1	No Manure	3484	3488	4448	3879
2	20 bushels Clay and Weed Ashes	3030	3336	4221	3857
	Mean	3257	3412	4335	3868
3	14 tons Farmyard Manure	3920	4682	7298	5852
		SERIES 2.—With			
4	Mixed Alkalies (Sulphates of Potash, Soda, and Magnesia)	3405	3521	4353	3873
5	Superphosphate of Lime	3459	3783	4898	3955
6	Superphosphate of Lime, and "Mixed Alkalies"	4008	4312	4969	4082
	Mean	3624	3872	4740	3970
	SERIES 3.—With Nitrogen per acre, equal to about 50 lbs.				
7	275 lbs. Nitrate of Soda, alone	*	4631	6475	5757
8	100 lbs each, Sulphate and Muriate of Ammonia, alone	4652	4950	6155	5148
9	100 lbs. each, Sulphate and Muriate of Ammonia, and "Mixed Alkalies"	4730	5079	6672	5579
10	100 lbs each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime	5127	5202	8017	5929
11	100 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime, and "Mixed Alkalies"	5487	5284	7958	6134
	Mean	4999	5029	7055	5709
	SERIES 4.—With Nitrogen per acre, equal to about 100 lbs.				
12	550 lbs. Nitrate of Soda, alone	*	4906	7400	6416
13	200 lbs. each, Sulphate and Muriate of Ammonia, alone	5490	5324	7548	6242
14	2000 lbs. Rape-Cake, alone	4949	5323	8238	6720
15	200 lbs. each, Sulphate and Muriate of Ammonia, and "Mixed Alkalies"	5378	5405	7315	6388
16	200 lbs each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime	5662	5615	8619	7027
17	200 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime, and "Mixed Alkalies"	5714	6134	9026	7054
18	2000 lbs. Rape-Cake, and "Mixed Alkalies"	4351	4943	7848	6676
19	2000 lbs. Rape-Cake, and Superphosphate of Lime	4713	5110	8388	6904
20	2000 lbs. Rape-Cake, and Superphosphate of Lime, and "Mixed Alkalies"	4796	5385	8125	6993
	Mean	5132	5350	8056	6713

* No Nitrate of Soda in 1852; but Sulphate of Potass, and Superphosphate of Lime.

during six consecutive Years on the same Land—1852, 53, 54, 55, 56, and 1857. Rothamsted, Herts.)

and STRAW together), per ACRE—in Lbs.

PRODUCE.		TOTAL (6 years).	Average Annual.	Average Annual Increase by Manure.	
1856.	**1857.**			Lbs.	With what Standard compared.
Standard Series.					
lbs. 1855	lbs. 3190	lbs. 20,344	lbs. 3391		
1981	3376	19,801	3300		
1918	3283	20,073	3345		
3866	5564	31,182	5197	1852	Over Unmanured.
Mineral Manures, only.					
1961	3426	20,539	3423	78	Over Unmanured.
1865	3606	21,566	3594	249	Over Unmanured.
2075	4111	23,557	3926	581	Over Unmanured.
1967	3714	21,887	3648	303	Over Unmanured.
Ammonia; both without and with direct Mineral Manures.					
3877	5389	† 26,129	† 5226	1881	Over Unmanured.
3547	4118	28,370	4729	1384	Over Unmanured.
3574	4702	30,336	5056	1633	Over "Mixed Alkalies" (No. 4).
3874	6161	34,310	5719	2125	Over Superphosphate of Lime (No. 5).
3981	6336	35,180	5863	1937	Over Superphosphate of Lime, and "Mixed Alkalies" (No. 6).
3731	5341	31,864	5319	1670	Over Mean of Mineral Series.
Ammonia; both without and with direct Mineral Manures.					
5450	6816	† 30,988	† 6198	2853	Over Unmanured.
4801	5360	34,765	5794	2449	Over Unmanured.
4780	7262	37,272	6212	2867	Over Unmanured.
4414	5618	34,518	5753	2330	Over "Mixed Alkalies" (No. 4).
5233	7383	39,539	6590	2996	Over Superphosphate of Lime (No. 5).
5582	7734	41,244	6874	2948	Over Superphosphate of Lime, and "Mixed Alkalies" (No. 6).
4673	6877	35,368	5895	2472	Over "Mixed Alkalies" (No. 4).
5447	7266	37,828	6305	2711	Over Superphosphate of Lime (No. 5).
5257	7241	37,798	6300	2374	Over Superphosphate of Lime, and "Mixed Alkalies" (No. 6).
5071	6840	37,162	6213	2565	Over Mean of Mineral Series.

† Taken for 5 years only.

RESULTS of EXPERIMENTS on the GROWTH of BARLEY by different MANURES:—made (Hoos-Field,

TABLE V.—PROPORTION of TOTAL

Experi-ments.	MANURES. (Quantities per Acre, per Annum.)	IN EACH 1852.	1853.	1854.	1855.
	SERIES 1.—Gauge, or				
1	No Manure	45·9	44·1	44·4	48·6
2	20 bushels Clay and Weed Ashes	47·9	46·6	45·1	51·4
	Mean	46·9	45·4	44·8	50·0
3	14 tons Farmyard Manure	47·0	45·6	42·8	47·2
	SERIES 2.—With				
4	Mixed Alkalies (Sulphates of Potash, Soda, and Magnesia) . .	45·8	45·0	46·4	49·5
5	Superphosphate of Lime	46·4	49·3	46·9	49·9
6	Superphosphate of Lime, and "Mixed Alkalies"	45·4	46·8	47·8	50·6
	Mean	45·9	47·0	47·0	50·0
	SERIES 3.—With Nitrogen per acre, equal to about 50 lbs.				
7	275 lbs. Nitrate of Soda, alone	*	44·1	42·3	47·4
8	100 lbs. each, Sulphate and Muriate of Ammonia, alone . . .	44·9	46·2	44·9	47·4
9	100 lbs. each, Sulphate and Muriate of Ammonia, and "Mixed Alkalies"	44·2	44·5	43·4	44·9
10	100 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime	43·1	45·2	42·9	44·5
11	100 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime, and "Mixed Alkalies"	43·1	43·7	43·1	43·3
	Mean	43·8	44·7	43·3	45·5
	SERIES 4.—With Nitrogen per acre, equal to about 100 lbs.				
12	550 lbs. Nitrate of Soda, alone	*	42·2	42·1	42·0
13	200 lbs. each, Sulphate and Muriate of Ammonia, alone . . .	45·3	45·0	43·9	42·3
14	2000 lbs. Rape Cake, alone	44·3	43·5	41·1	39·7
15	200 lbs. each, Sulphate and Muriate of Ammonia, and "Mixed Alkalies"	45·2	43·6	42·0	40·5
16	200 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime	43·8	43·4	42·3	38·5
17	200 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime, and "Mixed Alkalies"	44·3	42·2	39·2	36·6
18	2000 lbs. Rape Cake, and "Mixed Alkalies"	43·8	42·7	41·0	39·8
19	2000 lbs. Rape Cake, and Superphosphate of Lime	43·6	43·9	41·0	41·4
20	2000 lbs. Rape Cake, and Superphosphate of Lime, and "Mixed Alkalies"	43·7	42·7	42·0	39·8
	Mean	44·1	43·2	41·6	40·1

* No Nitrate of Soda in 1852; but Sulphate of Potass, and Superphosphate of Lime.

during six consecutive Years on the same Land—1852, 53, 54, 55, 56, and 1857. Rothamsted, Herts.)

CORN in 100 TOTAL PRODUCE.

YEAR. 1856.	1857.	Average Annual.	Difference according to Manure. Per Cent.	With what Standard compared.
Standard Series.				
45·8	50·8	46·6		
46·6	51·5	48·2		
46·2	51·2	47·4		
42·8	47·8	45·5	1·9	Less than Unmanured.
Mineral Manures, only.				
47·7	50·8	47·5	0·1	More than Unmanured.
47·5	51·6	48·6	1·2	More than Unmanured.
49·1	53·3	48·8	1·4	More than Unmanured.
48·1	51·9	48·3	0·9	More than Unmanured.
Ammonia; both without and with direct Mineral Manures.				
43·2	48·9	†45·2	2·2	Less than Unmanured.
42·8	51·8	46·3	1·1	Less than Unmanured.
44·1	49·0	45·0	2·5	Less than "Mixed Alkalies" (No. 4).
37·9	51·3	44·1	4·5	Less than Superphosphate of Lime (No. 5).
40·2	50·7	44·0	4·8	Less than Superphosphate of Lime, and "Mixed Alkalies" (No. 6).
41·6	50·3	44·9	3·4	Less than Mean of Mineral Series.
Ammonia; both without and with direct Mineral Manures.				
40·8	47·3	†42·9	4·5	Less than Unmanured.
42·9	50·8	45·0	2·4	Less than Unmanured.
39·1	48·8	42·7	4·7	Less than Unmanured.
33·7	48·2	42·2	5·3	Less than "Mixed Alkalies" (No. 4).
32·2	50·1	41·7	6·9	Less than Superphosphate of Lime (No. 5).
33·8	47·5	40·6	8·2	Less than Superphosphate of Lime, and "Mixed Alkalies" (No. 6).
36·6	49·7	42·3	5·2	Less than "Mixed Alkalies" (No. 4).
35·2	48·4	42·2	6·4	Less than Superphosphate of Lime (No. 5).
35·0	48·8	42·0	6·8	Less than Superphosphate of Lime, and "Mixed Alkalies" (No. 6).
36·6	48·8	42·4	5·9	Less than Mean of Mineral Series.

† Taken for 5 years only.

RESULTS of EXPERIMENTS on the GROWTH of BARLEY by different MANURES:—made (Hoos-Field,

TABLE VI.—PROPORTION of

Experiments.	MANURES. (Quantities per Acre, per Annum.)	IN EACH			
		1852.	1853.	1854.	1855.
	SERIES 1.—Gauge, or				
1	No Manure	90·8	86·1	94·6	92·9
2	20 bushels Clay and Weed Ashes	91·9	89·6	93·7	96·3
	Mean	91·3	87·8	94·2	94·6
3	14 tons Farmyard Manure	94·5	87·4	97·2	96·1
	SERIES 2.—With				
4	Mixed Alkalies (Sulphates of Potash, Soda, and Magnesia) . .	88·3	90·5	95·8	96·0
5	Superphosphate of Lime	93·8	94·6	95·6	96·5
6	Superphosphate of Lime, and "Mixed Alkalies"	92·5	92·1	95·6	95·4
	Mean	91·5	92·4	96·0	96·0
	SERIES 3.—With Nitrogen per acre, equal to about 50 lbs.				
7	275 lbs. Nitrate of Soda, alone	*	86·2	96·0	95·3
8	100 lbs. each, Sulphate and Muriate of Ammonia, alone . . .	89·6	88·9	92·7	94·4
9	100 lbs. each, Sulphate and Muriate of Ammonia, and "Mixed Alkalies"	87·9	85·1	93·2	92·9
10	100 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime	88·2	89·6	95·6	93·0
11	100 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime, and "Mixed Alkalies"	88·5	88·1	96·0	94·6
	Mean	88·5	87·6	94·7	94·0
	SERIES 4.—With Nitrogen per acre, equal to about 100 lbs.				
12	550 lbs. Nitrate of Soda, alone	*	89·0	90·8	91·7
13	200 lbs. each, Sulphate and Muriate of Ammonia, alone . . .	88·0	87·4	90·2	92·3
14	2000 lbs. Rape-Cake, alone	92·2	88·5	94·8	91·8
15	200 lbs. each, Sulphate and Muriate of Ammonia, and "Mixed Alkalies"	87·0	90·0	89·1	91·8
16	200 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime	87·3	89·7	91·0	93·3
17	200 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime, and "Mixed Alkalies"	90·3	88·4	92·3	94·2
18	2000 lbs. Rape-Cake, and "Mixed Alkalies"	90·0	86·0	92·3	93·1
19	2000 lbs. Rape-Cake, and Superphosphate of Lime	92·0	83·2	93·1	93·2
20	2000 lbs. Rape Cake, and Superphosphate of Lime, and "Mixed Alkalies"	93·1	88·0	93·3	92·0
	Mean	90·0	87·8	91·9	92·6

* No Nitrate of Soda in 1852; but Sulphate of Potass, and Superphosphate of Lime.

during six consecutive Years on the same Land—1852, 53, 54, 55, 56, and 1857. Rothamsted, Herts.)

DRESSED CORN in 100 TOTAL CORN.

YEAR. 1856.	YEAR. 1857.	Average Annual.	Difference according to Manure. Per Cent.	Difference according to Manure. With what Standard compared.
Standard Series.				
83·6	94·8	90·5		
86·5	93·9	92·0		
85·0	94·3	91·2		
91·5	95·4	93·7	2·5	More than Unmanured.
Mineral Manures, only.				
86·2	96·5	92·4	1·2	More than Unmanured.
93·3	94·3	94·7	3·5	More than Unmanured.
91·3	97·6	94·1	2·9	More than Unmanured.
90·3	96·1	93·7	2·5	More than Unmanured.
Ammonia; both without and with direct Mineral Manures.				
85·4	96·2	† 91·8	0·6	More than Unmanured.
84·6	94·7	90·8	0·4	Less than Unmanured.
88·6	96·0	90·6	1·8	Less than "Mixed Alkalies" (No. 4).
91·7	97·2	92·5	2·2	Less than Superphosphate of Lime (No. 5).
92·2	97·8	92·9	1·2	Less than Superphosphate of Lime, and "Mixed Alkalies" (No. 6).
88·5	96·4	91·7	2·0	Less than Mean of Mineral Series.
Ammonia; both without and with direct Mineral Manures.				
91·3	95·3	† 91·6	0·4	More than Unmanured.
85·0	95·0	89·6	1·6	Less than Unmanured.
90·7	96·2	92·4	1·2	More than Unmanured.
80·5	96·0	89·1	3·3	Less than "Mixed Alkalies" (No. 4).
86·2	96·4	90·6	4·1	Less than Superphosphate of Lime (No. 5).
90·7	95·0	91·8	2·3	Less than Superphosphate of Lime, and "Mixed Alkalies" (No. 6).
88·9	95·5	92·0	0·4	Less than "Mixed Alkalies" (No. 4).
91·5	95·2	91·4	3·3	Less than Superphosphate of Lime (No. 5).
88·9	95·2	91·7	2·4	Less than Superphosphate of Lime, and "Mixed Alkalies" (No. 6).
88·2	95·5	91·1	2·6	Less than Mean of Mineral Series.

† Taken for 5 years only.

RESULTS of EXPERIMENTS on the GROWTH of BARLEY by different MANURES:—made (Hoos-Field,

TABLE VII.—WEIGHT per BUSHEL

Experiments.	MANURES. (Quantities per Acre, per Annum.)	IN EACH			
		1852.	1853.	1854.	1855.
	SERIES 1.—Gauge, or				
1	No Manure	52·1	50·8	53·1	52·4
2	20 bushels Clay and Weed Ashes	53·0	50·9	53·6	52·6
	Mean	52·6	50·9	53·4	52·5
3	14 tons Farmyard Manure	52·7	51·6	53·9	52·9
	SERIES 2.—With				
4	Mixed Alkalies (Sulphates of Potash, Soda, and Magnesia)	52·5	51·9	53·6	52·9
5	Superphosphate of Lime	52·6	52·6	54·0	52·5
6	Superphosphate of Lime, and "Mixed Alkalies"	51·5	52·1	54·0	53·1
	Mean	52·2	52·2	53·9	52·8
	SERIES 3.—With Nitrogen per acre, equal to about 50 lbs.				
7	275 lbs. Nitrate of Soda, alone	*	51·3	53·2	52·0
8	100 lbs. each, Sulphate and Muriate of Ammonia, alone	50·7	52·4	53·6	51·8
9	100 lbs. each, Sulphate and Muriate of Ammonia, and "Mixed Alkalies"	50·9	52·6	54·0	52·2
10	100 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime	50·5	52·5	54·2	51·3
11	100 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime, and "Mixed Alkalies"	51·4	53·1	54·2	52·0
	Mean	50·9	52·4	53·8	51·9
	SERIES 4.—With Nitrogen per acre, equal to about 100 lbs.				
12	550 lbs. Nitrate of Soda, alone	*	49·7	53·1	50·1
13	200 lbs. each, Sulphate and Muriate of Ammonia, alone	49·1	51·3	52·7	50·6
14	2000 lbs. Rape Cake, alone	51·7	51·3	52·9	50·5
15	200 lbs. each, Sulphate and Muriate of Ammonia, and "Mixed Alkalies"	50·6	51·3	53·1	50·2
16	200 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime	49·5	51·7	52·4	50·1
17	200 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime, and "Mixed Alkalies"	50·6	51·4	52·1	48·9
18	2000 lbs. Rape Cake, and "Mixed Alkalies"	51·2	51·5	52·6	50·6
19	2000 lbs. Rape Cake, and Superphosphate of Lime	51·8	51·6	52·8	50·0
20	2000 lbs. Rape Cake, and Superphosphate of Lime, and "Mixed Alkalies"	51·4	50·4	52·8	49·5
	Mean	50·7	51·1	52·7	50·1

* No Nitrate of Soda in 1852; but Sulphate of Potass, and Superphosphate of Lime.

during six consecutive Years on the same Land—1852, 53, 54, 55, 56, and 1857. Rothamsted, Herts.)

of Dressed Corn—in Lbs. and Tenths.

YEAR. 1856.	1857.	Average Annual.	Difference according to Manure. Per Cent.	With what Standard compared.
Standard Series.				
49·5	52·1	51·7		
50·0	52·3	52·1		
49·8	52·2	51·9		
47·1	54·1	52·0	0·1	More than Unmanured.
Mineral Manures, only.				
48·5	52·5	52·0	0·1	More than Unmanured.
46·5	52·7	51·8	0·1	Less than Unmanured.
47·0	53·7	51·9	..	Same as Unmanured.
47·3	53·0	51·9	..	Same as Unmanured.
Ammonia; both without and with direct Mineral Manures.				
50·0	52·9	†51·9	..	Same as Unmanured.
48·5	51·9	51·5	0·4	Less than Unmanured.
49·1	52·1	51·8	0·5	Less than "Mixed Alkalies" (No. 4).
46·2	54·3	51·5	0·3	Less than Superphosphate of Lime (No. 5).
46·4	54·7	52·0	0·1	Less than Superphosphate of Lime, and "Mixed Alkalies" (No. 6).
48·0	53·2	51·7	0·2	Less than Mean of Mineral Series.
Ammonia; both without and with direct Mineral Manures.				
48·4	53·0	†50·9	1·0	Less than Unmanured.
48·3	52·0	50·7	1·2	Less than Unmanured.
46·1	53·2	50·9	1·0	Less than Unmanured.
47·2	52·0	50·7	1·3	Less than "Mixed Alkalies" (No. 4).
46·1	53·5	50·6	1·2	Less than Superphosphate of Lime (No. 5).
45·5	53·8	50·4	1·5	Less than Superphosphate of Lime, and "Mixed Alkalies" (No. 6).
46·6	54·1	51·1	0·9	Less than "Mixed Alkalies" (No. 4).
47·2	53·8	51·2	0·6	Less than Superphosphate of Lime (No. 5).
46·2	54·1	50·7	1·2	Less than Superphosphate of Lime, and "Mixed Alkalies" (No. 6).
46 8	53·3	50·8	1·1	Less than Mean of Mineral Series.

† Taken for 5 years only.

RESULTS of EXPERIMENTS on the GROWTH of BARLEY by different MANURES :—made (Hoos-Field,

TABLE VIII.—MEAN RESULTS of each CHARACTERISTIC MANURE, or CLASS of

Classes.	General Description of Manuring.	IN 1852.	1853.
		Dressed Corn per Acre,	
1	Unmanured (Mean of Unmanured, and Clay and Weed Ashes)	26 2	26 3
2	Farmyard Manure (14 tons per Acre, per Annum)	33 0	36 0¼
3	Mean by Mineral Manures, only	29 0¾	32 1
4	Mean, with Nitrogen = 50 lbs. Ammonia, per Acre per An. (both without & with Minerals)	38 0¼	37 2¼
5	Mean, with Nitrogen = 100 lbs. Ammonia, per Acre per An. (both without & with Minerals)	40 1¼	39 3
	Mean	33 1¾	34 2
		Total Corn	
1	Unmanured (Mean of Unmanured, and Clay and Weed Ashes)	1526	1547
2	Farmyard Manure (14 tons per Acre, per Annum)	1844	2136
3	Mean by Mineral Manures, only	1661	1823
4	Mean, with Nitrogen = 50 lbs. Ammonia, per Acre per An. (both without & with Minerals)	2190	2250
5	Mean, with Nitrogen = 100 lbs. Ammonia, per Acre per An. (both without & with Minerals)	2273	2314
	Mean	1899	2014
		Total Straw and	
1	Unmanured (Mean of Unmanured, and Clay and Weed Ashes)	1731	1865
2	Farmyard Manure (14 tons per Acre, per Annum)	2076	2546
3	Mean by Mineral Manures, only	1963	2049
4	Mean, with Nitrogen = 50 lbs. Ammonia, per Acre per An. (both without & with Minerals)	2809	2779
5	Mean, with Nitrogen = 100 lbs. Ammonia per Acre per An. (both without & with Minerals)	2858	3036
	Mean	2287	2455
		Total Produce (Corn and	
1	Unmanured (Mean of Unmanured, and Clay and Weed Ashes)	3257	3412
2	Farmyard Manure (14 tons per Acre, per Annum)	3920	4682
3	Mean, by Mineral Manures, only	3624	3872
4	Mean, with Nitrogen = 50 lbs. Ammonia, per Acre per An. (both without & with Minerals)	4999	5029
5	Mean, with Nitrogen = 100 lbs. Ammonia, per Acre per An. (both without & with Minerals)	5132	5350
	Mean	4186	4469
		Proportion of Total Corn,	
1	Unmanured (Mean of Unmanured, and Clay and Weed Ashes)	46·9	45·4
2	Farmyard Manure (14 tons per Acre, per Annum)	47·0	45·6
3	Mean, by Mineral Manures, only	45·9	47·0
4	Mean, with Nitrogen = 50 lbs. Ammonia, per Acre per An. (both without & with Minerals)	43·8	44·7
5	Mean, with Nitrogen = 100 lbs. Ammonia, per Acre per An. (both without & with Minerals)	44·1	43·2
	Mean	45·5	45·2
		Proportion of Dressed Corn,	
1	Unmanured (Mean of Unmanured, and Clay and Weed Ashes)	91·3	87·8
2	Farmyard Manure (14 tons per Acre, per Annum)	94·5	87·4
3	Mean by Mineral Manures, only	91·5	92·4
4	Mean, with Nitrogen = 50 lbs. Ammonia, per Acre per An. (both without & with Minerals)	88·5	87·6
5	Mean, with Nitrogen = 100 lbs. Ammonia, per Acre per An. (both without & with Minerals)	90·0	87·8
	Mean	91·2	88·6
		Weight per Bushel of Dressed	
1	Unmanured (Mean of Unmanured, and Clay and Weed Ashes)	52·6	50·9
2	Farmyard Manure (14 tons per Acre, per Annum)	52·7	51·6
3	Mean, by Mineral Manures, only	52·2	52·2
4	Mean, with Nitrogen = 50 lbs. Ammonia, per Acre per An. (both without & with Minerals)	50·9	52·4
5	Mean, with Nitrogen = 100 lbs. Ammonia, per Acre per An. (both without & with Minerals)	50·7	51·1
	Mean	51·8	51·6

during six consecutive Years on the same Land—1852, 53, 54, 55, 56, and 1857. Rothamsted, Herts.)

MANURES, for each of the separate Years; that is, comparing Season with Season.

EACH YEAR.				TOTAL (6 Years).	Average Annual.	Average Annual Increase by Manure.	
1854.	1855.	1856.	1857.			Lbs.	With what Standard compared.
in Bushels and Pecks.							
34 1	34 3¼	15 0½	30 1¼	167 3¼	28 0		
56 1½	50 0¼	32 0¼	51 1¼	259 1	43 0¼	15 0¾	Over Unmanured.
39 3	36 0¼	18 0¼	35 0	190 1¼	31 2¼	3 2¾	Over Unmanured.
53 2¼	47 0¼	28 2¼	48 2¼	253 2¼	42 2	10 3¼	Over Mean of Mineral Series.
58 1½	49 2¾	34 3¼	59 3¼	282 3½	47 0½	15 1¾	Over Mean of Mineral Series.
48 2	43 2¼	25 3	45 0	230 3	38 2		
per Acre—Lbs.							
1940	1934	886	1679	9,512	1585		
3127	2765	1656	2915	14,443	2407	822	Over Unmanured.
2231	1986	947	1931	10,579	1763	178	Over Unmanured.
3053	2594	1550	2689	14,326	2394	631	Over Mean of Mineral Series.
3350	2686	1854	3339	15,816	2643	880	Over Mean of Mineral Series.
2740	2393	1379	2511	12,936	2158		
Chaff per Acre—Lbs.							
2395	1934	1032	1604	10,561	1760		
4171	3087	2210	2649	16,739	2790	1030	Over Unmanured.
2509	1984	1020	1783	11,309	1885	125	Over Unmanured.
4002	3115	2181	2652	17,538	2925	1040	Over Mean of Mineral Series.
4706	4027	3217	3500	21,344	3570	1685	Over Mean of Mineral Series.
3557	2829	1932	2438	15,498	2586		
Straw together) per Acre—Lbs.							
4335	3868	1918	3283	20,073	3345		
7298	5852	3866	5564	31,182	5197	1852	Over Unmanured.
4740	3970	1967	3714	21,887	3648	303	Over Unmanured.
7055	5709	3731	5341	31,864	5319	1670	Over Mean of Mineral Series.
8056	6713	5071	6840	37,162	6213	2565	Over Mean of Mineral Series.
6297	5222	3311	4948	28,433	4744		
in 100 Total Produce.							
44·8	50·0	46·2	51·2	..	47·4		
42·8	47·2	42·8	47·8	..	45·5	1·9	Less than Unmanured.
47·0	50·0	48·1	51·9	..	48·3	0·9	More than Unmanured.
43·3	45·5	41·6	50·3	..	44·9	3·4	Less than Mean of Mineral Series.
41·6	40·1	36·6	48·8	..	42·4	5·9	Less than Mean of Mineral Series.
43·9	46·6	43·1	50·0	..	45·7		
in 100 Total Corn.							
94·2	94·6	85·0	94·3	..	91·2		
97·2	96·1	91·5	95·4	..	93·7	2·5	More than Unmanured.
96·0	96·0	90·3	96·1	..	93·7	2·5	More than Unmanured.
94·7	94·0	88·5	96·4	..	91·7	2·0	Less than Mean of Mineral Series.
91·9	92·6	88·2	95·5	..	91·1	2·6	Less than Mean of Mineral Series.
94·8	94·7	88·7	95·5	..	92·3		
Corn—Lbs. and Tenths.							
53·4	52·5	49·8	52·2	..	51·9		
53·9	52·9	47·1	54·1	..	52·0	0·1	More than Unmanured.
53·9	52·8	47·3	53·0	..	51·9		Same as Unmanured.
53·8	51·9	48·0	53·2	..	51·7	0·2	Less than Mean of Mineral Series.
52·7	50·1	46·8	52·3	..	50·8	1·1	Less than Mean of Mineral Series.
53·5	52·0	47·8	53·2	..	51·7		

RESULTS of EXPERIMENTS on the GROWTH of BARLEY by different MANURES:—made (Hoos-Field,

TABLE IX.—MEAN ANNUAL RESULTS of each of the different

Experiments.	MANURES. (Quantities per Acre, per Annum).	PARTICULARS OF QUALITY. Proportion of Total Corn, in 100 Total Produce.	Proportion of Dressed Corn, in 100 Total Corn.	Weight per Bushel of Dressed Corn, lbs. and tenths.
	SERIES 1.—Gauge, or			
1	No Manure	46·6	90·5	51·7
2	20 bushels Clay and Weed Ashes	48·2	92·0	52·1
	Mean	47·4	91·2	51·9
3	14 tons Farmyard Manure	45·5	93·7	52·0
	SERIES 2.—With			
4	Mixed Alkalies (Sulphates of Potash, Soda, and Magnesia)	47·5	92·4	52·0
5	Superphosphate of Lime	48·6	94·7	51·8
6	Superphosphate of Lime and "Mixed Alkalies"	48·8	94·1	51·9
	Mean	48·3	93·7	51·9
	SERIES 3.—With Nitrogen per acre, equal to about 50 lbs.			
7	275 lbs. Nitrate of Soda, alone	45·2	91·8	51·9
8	100 lbs. each, Sulphate and Muriate of Ammonia, alone	46·3	90·8	51·5
9	100 lbs. each, Sulphate and Muriate of Ammonia, and "Mixed Alkalies"	45·0	90·6	51·8
10	100 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime	44·1	92·5	51·5
11	100 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime, and "Mixed Alkalies"	44·0	92·9	52·0
	Mean	44·9	91·7	51·7
	SERIES 4.—With Nitrogen per acre, equal to about 100 lbs.			
12	550 lbs. Nitrate of Soda, alone	42·9	91·6	50·9
13	200 lbs. each, Sulphate and Muriate of Ammonia, alone	45·0	89·6	50·7
14	2000 lbs. Rape Cake, alone	42·7	92·4	50·9
15	200 lbs. each, Sulphate and Muriate of Ammonia, and "Mixed Alkalies"	42·2	89·1	50·7
16	200 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime	41·7	90·6	50·6
17	200 lbs. each, Sulphate and Muriate of Ammonia, and Superphosphate of Lime, and "Mixed Alkalies"	40·6	91·8	50·4
18	2000 lbs. Rape Cake, and "Mixed Alkalies"	42·3	92·0	51·1
19	2000 lbs. Rape Cake, and Superphosphate of Lime	42·2	91·4	51·2
20	2000 lbs. Rape Cake, and Superphosphate of Lime, and "Mixed Alkalies"	42·0	91·7	50·7
	Mean	42·4	91·1	50·8

during six consecutive Years on the same Land—1852, 53, 54, 55, 56, and 1857. Rothamsted, Herts.)

Manures, taking for each the average of six Years.

Particulars of Quantity.												
Average Annual Produce (per Acre).				Average Annual Increase, where Mineral Manures are employed, compared with equal other conditions, without them.			Average Annual Increase, where Nitrogen is added in Manure, compared with equal other conditions, without it.			Average Annual Total Increase by Manure over the Standard Unmanured.		
Corn.	Corn.	Straw.	Total Produce.	Corn.	Straw.	Total Produce.	Corn.	Straw.	Total Produce.	Corn.	Straw.	Total Produce.
Standard Series.												
bus. pks.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
27 3	1578	1812	3391									
28 0¾	1592	1708	3300									
28 0	1585	1760	3345									
43 0¾	2407	2790	5197							822	1030	1852
Mineral Manures, only.												
28 3¾	1627	1796	3423	42	36	78				42	36	78
31 2¾	1748	1846	3594	163	86	249				163	86	249
34 2	1914	2012	3926	329	252	581				329	252	581
31 2¼	1763	1885	3648	178	125	303				178	125	303
Ammonia; both without and with direct Mineral Manures.												
42 0¼	2364	2862	5226				779	1102	1881	779	1102	1881
38 2½	2191	2538	4729				606	778	1384	606	778	1384
39 2¾	2272	2784	5056	81	246	327	645	988	1633	687	1024	1711
45 2½	2545	3174	5719	354	636	990	797	1328	2125	960	1414	2374
46 1	2596	3267	5863	405	729	1134	682	1255	1937	1011	1507	2518
42 2	2394	2925	5319	280	537	817	710	1090	1792	809	1165	1974
Ammonia; both without and with direct Mineral Manures.												
47 3¾	2666	3532	6198				1081	1772	2853	1081	1772	2853
46 0	2603	3191	5794				1018	1431	2449	1018	1431	2449
48 0¾	2664	3548	6212				1079	1788	2867	1079	1788	2867
42 3½	2441	3312	5753	—162	121	—41	814	1516	2330	856	1552	2408
49 2¼	2775	3815	6590	172	624	796	1027	1969	2996	1190	2055	3245
50 3	2801	4073	6874	198	882	1080	887	2061	2948	1216	2313	3529
44 2	2505	3390	5895	—159	—158	—317	878	1594	2472	920	1630	2550
47 2¾	2673	3632	6305	9	84	93	925	1786	2711	1088	1872	2960
48 0	2662	3638	6300	—2	90	88	748	1626	2374	1077	1877	2955
47 0½	2643	3570	6213	9	274	283	940	1727	2667	1058	1810	2868

It not unfrequently happens, too, that some passing abnormal conditions, may affect the crop more strikingly than from the registry of characters for a period would be traceable—unless with the aid of coincident careful observation, and consideration of the stage of progress and tendencies of growth at the time, of the crop itself.

Still some broad features of climatic influence may usefully be indicated in connexion with the very different amounts and character of produce obtained under equal supplied conditions in the several seasons. To make these more intelligible, it will be well to bring to one view from the Tables, some few statements of quantity and quality of produce, illustrative of the effects on the crop of the different seasons. This is done in the short Summary Table, No. X., which follows. Perhaps upon the whole, the produce obtained year after year by a pretty complete purely mineral manure, is open to as little exception, taken as a measure or representative of the intrinsic influence of season upon the crop, as that under any other individual condition of manuring which our series includes. Accordingly the results of the Mixed Mineral Manure, No. VI., are selected for this purpose; and in the Summary Table (No. X.), is given each of our enumerated characters of quantity and quality of the produce by the manure in question, in each of the six years of the experiments.

TABLE X.

SHOWING the QUALITY and QUANTITY of the produce of BARLEY, by a full purely MINERAL MANURE, in each of the six Seasons.

Years.	Particulars of Quality.			Particulars of Quantity. Produce per Acre.				
	Proportion of Total Corn in 100 Total Produce.	Proportion of Dressed Corn in 100 Total Corn.	Weight per Bushel of Dressed Corn.	Dressed Corn.		Total Corn.	Straw and Chaff.	Total Produce.
			lbs.	bush.	pcks.	lbs.	lbs.	lbs.
1852	45·4	92·5	51·5	32	3	1819	2189	4008
1853	46·8	92·1	52·1	35	$2\frac{1}{2}$	2017	2295	4312
1854	47·8	95·6	54·0	42	0	2374	2595	4969
1855	50·6	95·4	53·1	37	$0\frac{3}{4}$	2067	2015	4082
1856	49·1	91·3	47·0	19	3	1018	1057	2075
1857	53·3	97·6	53·7	39	$3\frac{1}{4}$	2191	1920	4111
Average .	48·8	94·1	51·9	34	2	1914	2012	3926

The examination of this Table will show the actual and comparative influence of the respective seasons, upon the seven different characters of the produce recorded. It is seen at a glance, that no one season carries with it high condition on every

character of quality and quantity. A clearer perception of how ever-varying are the mutual adaptations of climatic character to stage and tendency of development of the plant, will however be gained by looking at the results in a somewhat converse form. Thus, in Table XI., for each particular of quality and quantity of produce, the years themselves are arranged, in the order in which they severally afforded the highest result.

TABLE XI.

ORDER of the SEASONS in influencing the several characters of the QUALITY and QUANTITY of the PRODUCE of BARLEY, grown year after year, by purely Mineral Manures.

	Order of adaptation of the years	1st.	2nd.	3rd.	4th.	5th.	6th.
For Quality as represented by	Proportion of Total Corn in 100 Total Produce	1857	1855	1856	1854	1853	1852
	Proportion of Dressed Corn in 100 Total Corn.	1857	1854	1855	1852	1853	1856
	Weight per Bushel of Dressed Corn (lbs.)	1854	1857	1855	1853	1852	1856
	Summary of Order for Quality of Produce	1857	1854	1855	1853	1852	1856
For Quantity as represented by	Total Corn per Acre (lbs.)	1854	1857	1855	1853	1852	1856
	Total Straw per Acre (lbs.)	1854	1853	1852	1855	1857	1856
	Total Produce (Corn and Straw) per Acre, lbs.	1854	1853	1857	1855	1852	1856
	Summary of Order for Quantity of Produce	1854	1857	1855	1853	1852	1856
	Summary of Order for both Quality and Quantity of Produce	1854	1857	1855	1853	1852	1856

From these two Tables we gather (and the indication is upon the whole borne out by the produce of the other manures), that although 1854 was the year of considerably the highest *actual amount* of corn as well as straw—that is, the year of highest *quantity*—it gave by no means a relatively high *proportion* of corn. In respect to the latter point, of the other seasons, 1857 and 1855 stood considerably higher than 1854. It is at once seen on the other hand that, of all the years, 1856 was strikingly the worst in every point, both of quantity and quality, excepting the one of *proportion* of total corn; and it may be mentioned, that even in this it was so, where nitrogenous manures were employed.

Setting our standard of qualities of season for tendency to *corn*, rather than for the production of bulk of total produce—with which, under high farming, there would seldom be the highest either actual amount of corn, or proportion of it to the manure employed—it may be said that high character involves generally, during the later periods of growth, high relative temperature, with this a high range, a limited amount and distribution of rain, and high relative degree of barometric pressure. So far as general coincidence on these more prominent points is concerned, both

1857 and 1855, the years (particularly the former) of high proportion of corn, stand higher in the meteorological registry than 1854, which was the year of largest total produce, both corn and straw, and of highest weight per bushel of corn. The characters of season favouring quality and quantity respectively, are indeed in a certain degree opposite; and the high actual amount of corn in 1854, was due rather to enormous general growth, succeeded by pretty favourable maturing conditions.

The characters of the season of 1854 were indeed, almost throughout, much more those of continuity and bulk of growth than of special tendency to seeding. Thus, the seed was put in rather earlier than in any of the other years—April was comparatively warm, with little though distributed rain, and a moist atmosphere—May had scarcely average temperatures, a moist atmosphere, a very large fall of rain, and a large number of rainy days—June averaged very low maximum temperatures, and had a very small range of temperature, a moderately moist atmosphere, and not much amount, but considerable distribution of rain—July averaged rather low temperatures, had only a moderate amount and distribution of rain, and not much moisture in the atmosphere. Lastly, August commenced with low temperatures, had then for a period only moderate and even low temperatures, but concluded with higher ones; it had a large amount of rain in the earlier, a small amount in the intermediate, and still less in the later periods, also almost throughout, a moderately dry atmosphere—thus giving conditions of further growth almost up to the last, and finally, favourable maturing characters. Taking the season of 1854 as a whole then, we have a long and almost unbroken period favouring extended growth, and finally, good conditions of ripening. The result is an enormous bulk of total produce, and though the largest *actual*, nearly the smallest *proportional* amount of corn.

Let us take another extreme. Tables X. and XI. show that 1856 was the worst of all the years, for almost every point, both of quality and quantity of produce. Its vicissitudes were very great. April was moderately warm and wet—May had comparatively very little warm weather, its amount and distribution of rain were very large, but the atmosphere was frequently comparatively dry—June reached both high and very low temperatures, had a considerable mean range of temperature, not much amount, and limited distribution of rain, but frequently a very moist atmosphere—July again reached comparatively very low temperatures, had a more than average range, considerably below the average fall of rain, yet a moderate average amount of moisture of atmosphere. Finally, August, the ripening month, in its first week reached both very high and very low temperatures, giving an enormous range, and had very little rain; in its second week,

August had again very high maximum temperatures, but somewhat high minimum also, giving a high mean, and still a comparatively high range, and its fall of rain, though small, was distributed; in the third week the mean maximum temperatures were unusually low, and the minimum moderately so, giving low both mean and range, there was more or less rain every day, and a very large total fall; and lastly, the fourth week again averaged very low maximum temperatures, but not low minimum, and had but a small fall of rain, whilst almost throughout the month there was a good deal of atmospheric moisture. Thus then, with some very high maximum, and some very low minimum temperatures during the first half of the month (which was the last fortnight of growth of the standing crop), little rain, but frequently a moist atmosphere—then followed at the time of cutting with very low temperatures, a very excessive fall of rain, and still a moist atmosphere—we had a laid and sprouted crop. This season of 1856 was then one of very great vicissitudes, almost throughout the important stages of the progress of the plant. Hence, as Tables X. and XI. show, and as presently will be further seen, we had the worst crop of any in the series, in every point, both of quality and quantity of the produce.

These few statements of the characters of the seasons most contrasted in their effects upon the crop, will at any rate serve to direct the mind of the reader upon the subject, and thus prepare the way for a consideration of what are the actual amounts of variation in the quantity and quality of the produce—with equal conditions supplied at the cost of the farmer—due to that uncontrollable influence, *the weather*.

Discussing then the actual amounts of variation in the quality and quantity of the produce dependent upon variation of *season*, before going to that more peculiarly due to *manuring*, the Summary Table, No. VIII., will afford the facts for our illustration. We have in that Table the mean produce for each of the years, for each of five characteristic conditions of manuring, so that, though not just now considering for themselves the effects of the different manures, we shall nevertheless see to what extent the respective seasons, compared one with another, maintain any characteristic influence upon the crop under widely differing conditions of manuring.

Looking first to the mean unmanured produce, it is at once observed that we have in some of the seasons twice as much, both of corn and of straw, as in others. Thus, the total unmanured produce (corn and straw together) is, in the very bad season of 1856, only 1918 lbs.; whereas in 1854 and in 1855 it is more than twice, and in the other three years nearly twice as much. The amount of dressed corn, without manure, in 1856,

was only 15 bushels, and the weight per bushel was under 50 lbs. In 1857 we had, without manure, $30\frac{1}{3}$ bushels, with a weight of $52\frac{1}{4}$ lbs. per bushel; in 1854, $34\frac{1}{2}$ bushels, with $53\frac{1}{2}$ lbs. weight per bushel; in 1855 nearly 35 bushels, of $52\frac{1}{2}$ lbs. weight each, and in 1852 and 1853 from 26 to 27 bushels, with $52\frac{1}{2}$ and 51 lbs. weight per bushel respectively. Again, in 1857 and 1855, the seasons favourable to corn-yielding, we had 50 to 51 per cent. of corn in total produce; and in the other years there was only from 45 to 47 per cent. The proportion of corn was the least in 1854, the year of heaviest produce, and in 1856 the one of lightest produce, and also of greatest inferiority in every other respect. The proportion of corn dressed out as offal was also more than twice as great in 1856, and the comparative inferior season 1853, as in either of the favourable seasons 1857, 1855, or 1854.

A further inspection of Table VIII. will show, that the same general relation of the seasons to one another as regards the relative quantity and quality of the produce they yielded is traceable under the very various conditions of manuring, as with the unmanured crop. It is true that with heavy manuring, the worse proportionally, is the effect of adverse season. But the general result still remains, that the seasons keep their position in relation to one another almost unchanged, whatever the condition of manuring, even though the actual amount of produce with manure, as is frequently the case, is nearly double that without it. In every year (though in 1857 less than in the rest) the crops most heavily manured were much laid, and more or less damaged, and hence the much best *proportion of corn in total produce* with these manures, even in the last year 1857, than where the crop was unmanured, or only mineral manures were employed.

From the pervading influence of *season*, by which the produce may be double as much one year as another, even with one and the same set of conditions supplied by the farmer, and by which, when unfavourable, the crops most highly manured suffer most, it results that the amount of produce obtained for a given outlay in manure may be only half as much in some seasons as in others. And, as will be more fully illustrated further on, the higher the condition of manuring, if beyond a somewhat even narrow limit, the less will be the return of produce for a given quantity of manure. This brings us to a consideration of the effects of the individual *manures* employed in the experiments, leaving the reader to study for himself more in detail the variations in result from season to season, which have been above broadly indicated.

Dispensing then with any further detailed consideration of the

records for the individual years, which are provided for full reference in Tables I. to VIII. inclusive, we will now direct more particular attention to Table IX., in which is given the mean annual result over six consecutive years, of each of the twenty descriptions of manure employed.

Before entering upon the examination of the *mean annual result* of the individual manures, it should be stated that, in the detailed Tables, there is no evidence of any gradual either falling off, or increase of result from year to year, such as should vitiate the adoption of the average of the six years, as a measure of the actual or comparative effects of the different manures. Thus, the first two years were in many points very much alike in result, and they agree very nearly with the average of the six. The next two years, 1854 and 1855, but particularly the former, were above the average in their amount of produce. Lastly, the fifth year, 1856, was the worst of all; and the present year, 1857, the sixth in succession, was above the average on every point, and nearly the best of the series on some. So far then the average result of the six years may be taken, provided only that the number and character of the *seasons themselves* are admitted to afford a sufficient range, to indicate a fair average effect of the different manures. How far results obtained by the use of the same description of manure to the same crop grown on the same land through a series of years consecutively, can afford an indication of the requirements of barley as grown ordinarily in rotation, is of course a matter of separate consideration.

The descriptions of the manures, and the quantities of them employed, are partially given in the Tables, and the necessary further explanations on these points will be found at p. 455. In the Tables the twenty plots are divided into four classes, according to the general character of their manures, as under:—

1st *Gauge Series*—Comprising the unmanured portions, and a portion manured with clay and weed ashes; also the farmyard manure plot. The mean result of the unmanured and ash portions taken together, forms one—and that of the farmyard manure another—standard of comparison, by which to judge of the effects of the other manures.

2nd *Series—Mineral Manures* only—Comprising three plots; one having "*Mixed Alkalies*" (sulphates of potash, soda, and magnesia); another Superphosphate of Lime; and the third, both the "Mixed Alkalies," and Superphosphate of Lime. The results of this series should show us the extreme effect obtainable from the available normal supplies of nitrogen (terrestrial and atmospheric). They also serve as a point of comparison of the effects of nitrogen artificially supplied in addition, as in the following Series 3 and 4.

3rd *Series.*—In this series nitrogen is supplied by manure at a rate equal to about 50 lbs. of ammonia per acre per annum. The nitrogen is supplied respectively in the forms of nitrate of soda, and of an equal mixture of sulphate and muriate of ammonia. The ammoniacal salts are supplied both alone, and in admixture with each of the three several mineral-manures conditions of Series 2. The amount of nitrogen here supplied is perhaps fully as much as can be used with impunity for the barley crop on the soil in question, taking the average of seasons. The crop would be over-luxuriant and laid, with a larger amount.

4th *Series.*—Here the nitrogen is supplied at a rate equal to about 100 lbs. of ammonia per acre per annum. This amount is given in the three separate forms of nitrate of soda, the equal mixture of sulphate and muriate of ammonia, and as rape cake.* The mixture of ammoniacal salts, and also the rape cake, are each given, both alone and in admixture with each of the three mineral conditions above specified. As above implied, the nitrogen here provided, is beyond that which gives the best result in proportion to the amount of manure employed.

According to the notes taken in the field, the unmanured, and the only mineral manured portions, as a rule stood up till the time of cutting. The crops with nitrogen equal 50 lbs. ammonia per acre, were generally more or less laid; as also were those grown by farmyard manure. Those having nitrogen equal 100 lbs. or more of ammonia per acre were invariably laid; and in every year, excepting in 1857, very much and injuriously so, the crops being far too heavy to bear any moderate amount of rain about or after the time of heading.

The effect of the "Mixed Alkalies" on the condition of the crop, whether used alone or in admixture with nitrogenous manures, was invariably somewhat to retard its ripening. Superphosphate of lime, on the contrary, whether alone or in admixture, always tended to early ripening. The effect was most striking. So much so indeed, that latterly it has been thought desirable to cut the crops at different times as they came ripe; the superphosphate ones and the farmyard-manure coming to the scythe more than a week earlier than the others. It will presently be seen that the superphosphate had a marked effect on the quantity of produce also, and especially on the tendency to corn. Owing to the frequent falling of the crop, where nitrogenous manures were also employed, the result was, how-

* For convenience, the rape cake plots are classed as in the Tables; but it is probable that the 2000 lbs. per acre employed, would contain nearer 100 lbs. of *nitrogen;* the latter amount would be equal to about 121½ instead of 100 lbs. of *ammonia.*

ever, seldom so favourable at harvest as from appearances it previously promised to be.

Bearing in mind these general tendencies of effect of the different manures, which, owing to the incidental though uncontrollable fluctuations of season, are of course not so exactly numerically reflected as they would be under constant and favourable conditions of climate, let us see what really are the comparative results which the figures show?

In the left hand division of Table IX. will be found the average annual effects of the different manures upon the *quality* of the produce. These are indicated by the *proportion of corn in the total produce, the proportion of dressed corn in total corn, and the weight per bushel of the dressed corn.* In the right hand division of the Table are given the particulars of *quantity;* namely, the average annual bushels of corn per acre, and the amount in lbs. per acre, respectively of the total corn, of the straw, and of total produce (corn and straw together).

There are also given under the head of particulars of *quantity*, the average annual *increase* of corn and of straw, &c., by different manures, compared with the produce of others adopted as standards.

Looking first to the columns of *quality*, it is seen that the addition of the ashes, which do not increase the total produce, gives a tendency to an increased proportion of corn, a somewhat larger proportion of dressed corn, and a slightly higher average weight per bushel of dressed corn when compared with the unmanured produce. Taking the same standard of comparison, the farm-yard manure, probably because the crop was generally laid, did not give a higher average proportion of total corn; but the proportion of dressed corn, and the weight per bushel of the dressed corn, were somewhat higher. Comparing Series with Series, the mineral manures alone gave higher qualities of produce in all three respects than either the unmanured produce, or that of the series with nitrogenous manures. The produce of the Series with nitrogen = 50 lbs. of ammonia per acre, was generally inferior in the qualities enumerated to the unmanured produce; and that of the Series with the nitrogen equal to 100 lbs. or more of ammonia per acre, stands lower still in all these points of quality, depending as they do so materially on the standing up and favourable maturing of the crop.

Going a little more into detail, it is seen that where the mineral manures were used alone, the superphosphate of lime had a marked effect on the proportion of total corn; and also upon the perfection of that corn; as indicated by the amount of the dressed, in 100 of the total corn. The influence of the mineral manures on the quality of the produce, and especially that of the

superphosphate of lime, was exactly the reverse when used in combination with the nitrogenous manures. This result was, however, obviously due to the over luxuriance and laying of the crop, rather than to the intrinsic effects of the mineral manures themselves; which, when the produce was not too heavy for the season, were seen to be of a directly opposite character. In fact the gradations of inferiority as to tendency to corn, and quality of produce generally, are shown by the figures to be so closely connected with increase in total quantity, that they must obviously be attributed much more to the adverse influence of season upon a bulky crop than to any intrinsic influence of the manures employed.

Before leaving the question of the qualities of the produce under the different manures, it may be observed, that whether yielding nitrogen equal to 50 or 100 lbs. of ammonia per acre, the ammoniacal salts gave a higher average proportion of corn in the total produce than the nitrate of soda. This would appear to be due to a more rapid action of the nitrate. For, as will presently be seen, though it gave a less *proportion* of corn, it gave in both cases a larger *actual amount* of it, and particularly a larger amount of straw, or total bulk of produce, indicating a more luxuriant growth.

Let us now turn from the columns of *quality* to those of *quantity*. We see, as already alluded to, that the clay and weed ashes gave a slightly higher average amount of corn, and lower average amount of straw, and of total produce, than the unmanured plot. The latter indeed gave an annual average of 91 lbs. more *total produce* than the clay and weed ashes. There need therefore be no fear entertained that the results of the other manures, which, for the purpose of even distribution over the land, were mixed with always smaller quantities of these ashes, are at all materially affected thereby.

As before stated, it is the mean result of the unmanured plots, and of that manured with the clay and weed ashes, that is taken as the standard wherewith to compare the effects of the different manures. The average annual amount of this standard or normal produce of the unaided soil and season, was 1585 lbs. (= 28 bushels) of corn, 1760 lbs. of straw, &c.; making 3345 lbs. of total produce, corn and straw together. Above this amount, 14 tons per acre of ordinary farmyard dung, gave an average annual increase of 822 lbs. (= about 15 bushels) of corn, and 1030 lbs. of straw. The yearly gain in total produce by this manuring was therefore 1852 lbs., or considerably less than a ton.

Reckoning the farmyard manure to contain about 75 per cent. of water, and the 1852 lbs. of increased produce obtained by it to consist of about one-sixth water, we have an average annual

yield of 1543 lbs. of gross dry substance in the increase of produce, by the use of about 7840 lbs. of gross dry substance in manure. It is clear, therefore, that the great bulk of the solid matter of the dung, which consists mainly of highly carbonaceous organic substance, had little to do with the increase in the produce of the barley.

A study of the effects of the other individual manures, which replace one or more, as the case may be, of the constituents of the dung, should enable us to judge to which constituent, or constituents, of the latter, its effects on the barley-crop are mainly due.

By the annual use of "*mixed alkalies*"—sulphates of potash, soda, and magnesia—in amounts containing much more of the respective bases than the total annual produce, we obtain an average annual increase of only 42 lbs. of corn and 36 lbs. of straw, = 78 lbs. total increase.

The annual application of the *superphosphate of lime alone* gave a yearly increase of 163 lbs. of corn, and 86 lbs. of straw, = 249 lbs. of total increase; or 171 lbs. more than the "*mixed alkalies.*"

The combination of both the "*mixed alkalies*" and the *superphosphate of lime* gave an annual increase of 329 lbs. of corn and 252 lbs. of straw, = 581 lbs. of total increase; that is 503 lbs. more total increase than the "*mixed alkalies*" alone; 332 lbs. more than the *superphosphate of lime* alone; and 254 lbs. more than the sum of the increase by the two manures when each was used separately.

We shall refer more specially to the beneficial action of direct mineral manures on the barley crop further on; but that we may do so with advantage, it will be convenient first to consider the results of Series 3 and 4, in which they were employed, not alone as in the cases just considered, but in conjunction with nitrogenous manures.

Instead of 3345 lbs. of total produce, the average annual amount without manure, we have by the use of *nitrate of soda alone* (containing nitrogen equal to about 50 lbs. of ammonia), 5226 lbs., and by *salts of ammonia alone* (supplying about the same acreage amount of nitrogen) we have an average annual total produce of 4729 lbs. The average annual increase by nitrate of soda was rather more than 14 bushels of dressed corn (779 lbs. total corn), and 1102 lbs. of straw; and that by the ammoniacal salts was about $10\frac{3}{4}$ bushels of dressed corn (= 606 lbs. total corn), and 778 lbs. of straw. There was, indeed, by *nitrate of soda alone*, only 43 lbs. less corn, and even more straw and total gross produce, than by the 14 tons of farmyard-manure. *The salts of ammonia alone*, which

yielded a less result than the nitrate in relation to the assumed amount of nitrogen supplied, gave 216 lbs. less corn, and about 252 lbs. less straw, than the farmyard manure.

Unless, then, we are to attribute some important influence to the soda of the nitrate, or to the sulphuric acid and chlorine of the ammoniacal salts, we have here, by the supply in manure, of available nitrogen alone (= about 50 lbs. ammonia per acre per annum), in one case even more, and in the other somewhat less, of annual total produce, than by the whole of the constituents of the annually supplied 14 tons of dung.

In experiments 9, 10, and 11, we have the same amount of ammoniacal salts as in No. 8, but now in conjunction with one or other of the respective mineral manures of Nos. 4, 5, and 6. The addition of the "mixed alkalies" (salts of potash, soda, and magnesia) to the ammoniacal salts, raises the average annual produce by 81 lbs. of corn and 246 lbs. of straw. Estimating the result the converse way, the addition of the ammoniacal salts, as in No. 9, to the "*mixed alkalies*," as in No. 4, has given an increase of 645 lbs. corn and 988 lbs. of straw. Or, if we compare the result of the combination of the ammoniacal salts and the "mixed alkalies" with the unmanured produce, the combination has given an increase of 687 lbs. of corn and 1024 lbs. of straw, against 822 lbs. increase of corn and 1030 lbs. of straw by the farmyard-manure. Supplied nitrogen (about 41 lbs. per acre), and salts of the fixed alkaline bases, have therefore nearly reached the result of 14 tons of farmyard-manure.

In experiment No. 10 *superphosphate of lime* is the mineral manure added to the ammoniacal salts of No. 8. The addition of the *superphosphate of lime* increased the produce by 354 lbs. of corn and 636 lbs. of straw (= 990 lbs. total produce) over that by the ammoniacal salts alone. Calculating conversely, the addition of *ammoniacal salts to superphosphate of lime* gave an average annual increase of 797 lbs. of corn and 1328 lbs. of straw over the produce of the latter alone, against an increase of 606 lbs. of corn, and 778 lbs. of straw, over the unmanured produce when the same amount of ammoniacal salts were used alone. Again, by the conjoint action of ammoniacal salts and superphosphate of lime, we get an average annual increase over the unmanured produce, of 960 lbs. of corn and 1414 lbs. of straw, against an increase of only 822 lbs. of corn and 1030 lbs. of straw, by the farmyard-manure.

In experiment No. 11 we have, in addition to the same amount of ammoniacal salts as before (containing about 50 lbs. of ammonia), both the "*mixed alkalies*" and the *superphosphate of lime*, as in No. 6. The increase of No. 11 over No. 10 by the addi-

tion of the "*mixed alkalies*" to the superphosphate of lime and ammoniacal salts of the latter, is only 51 lbs. of corn and 93 lbs. of straw; or little more than that of the "mixed alkalies" over the unmanured produce when they were used alone. Thus the total annual gain (in experiment 11) by the addition of both the "mixed alkalies" and phosphatic manure to the ammoniacal salts (of experiment 8), is 405 lbs. of corn and 729 lbs. straw; that is, rather more than by the addition to the ammoniacal salts of superphosphate of lime alone. On the other hand, calculating the effect of the addition of the 50 lbs. of ammonia per acre per annum to the mixed mineral manure of No. 6, it is seen to be 682 lbs. of corn and 1255 lbs. of straw. And lastly, the average annual increase over the unmanured produce, due to the conjoint effects of the ammoniacal salts, the "mixed alkalies," and the superphosphate of lime, is 1011 lbs. of corn and 1507 lbs. of straw; which is 189 lbs. corn and 477 lbs. straw, more than by the farm-yard-manure.

From the results of Series 3, as a whole, we see that the mean annual increase by the supply to the soil of *nitrogen* = 50 lbs. of ammonia per acre per annum, in the five different states, or conditions of combustion, is 710 lbs. of corn and 1090 lbs. of straw, or 112 lbs. less corn, and 60 lbs. more straw, than by the farm-yard-manure. Or, taking the increase over the unmanured produce, due to the conjoint action of the mineral manures and supplied nitrogen (as in experiments 9, 10, and 11), its mean annual amount, calculating from 18 experiments (that is with three different mineral conditions each over six years), is 64 lbs. more corn and 285 lbs. more straw than by the dung. Or, lastly, if we take the conjoint action of the 50 lbs. of ammonia, and those mineral manures only which contain phosphates, we have from 100 to 200 lbs. more corn and from 400 to 500 lbs. more straw, per acre per annum, by such a combination, than by farmyard-manure.

In the next series (4), as already mentioned, there was about twice as much nitrogen supplied per acre as in experiments 7, 8, 9, 10, and 11, in which, as has just been seen, the amount of produce averaged more, and sometimes greatly exceeded, that by a large annual supply of farmyard dung. It should be stated in the outset, that the quantities of nitrogen now under consideration were considerably beyond what the barley could turn to good account with such seasons on the soil in question, as was shown by the invariable falling of the crop, and the consequent deficient proportion and quality of the corn. The result of this was, that we had in every case very much less increase of produce for a given amount of manure in Series 4 than in Series 3. In fact, there is, on the average, only about once and a half as much

increase, obtained by the use of nitrogen equal 100 lbs. or more of ammonia per acre per annum, as by the 50 lbs. or its equivalent of nitrogen. Bearing in mind this general result of an excessive amount of nitrogen supplied, the figures are still deserving some examination.

In this Series 4, the nitrogen was provided in the three separate forms of *nitrate of soda*, an equal mixture of *sulphate and muriate of ammonia*, and *rape-cake*. In Series 3, the quantities of ammoniacal salts and nitrate of soda employed per acre were 100 lbs. each, sulphate and muriate of ammonia, and 275 lbs. of the nitrate; the 200 lbs. of mixed ammoniacal salts and the 275 lbs. of nitrate of soda having been taken as containing respectively in round numbers 41 lbs. of nitrogen, = 50 lbs. of ammonia.

In Series 4, double the amounts, maintaining therefore the same proportions to one another, of the ammoniacal salts and nitrate, were employed. These quantities were adopted on the assumption that the equal mixture of the ammoniacal salts, in the condition in which they are sold in commerce for manure (though we always use the best at our command for experimental purposes), will average about 8 per cent. of water and impurity, and the nitrate about $8\frac{3}{4}$ per cent.* It is probable, however, that the nitrate will frequently come up nearer to the chemical standard of composition than the ammoniacal salts, and if so, our supposed equivalent amount of nitrate will contain a correspondingly larger amount of nitrogen than the ammoniacal salts; and this may partly, though not entirely, account for the greater effects obtained by the nitrate employed. The amount of rape-cake employed in Series 4 was 2000 lbs. per acre per annum; and it is assumed in the Tables, and also sometimes when speaking of the results, that the amount of nitrogen thus supplied was about the same as that in the larger amounts of ammoniacal salts and nitrate used by its side. This would, however, suppose a lower per cent. of nitrogen in the rape-cake than the average of our own determinations, or the records of those of others, would indicate. It is, indeed, not improbable that the 2000 lbs. of rape-cake would frequently contain nitrogen equal to from 110 to even 120 lbs. of ammonia. It is probable, on the other hand, that the nitrogen of the rape-cake will be given up from its existing combinations, in less proportion each year than that in either of the other two forms. Although, therefore, all the experiments included in Series 4 are so brought together for the convenience of

* These deductions are probably in both cases rather excessive. It frequently happens, indeed, that sulphate of ammonia in the bulk, will average less water of crystallization than is theoretically accorded to it.

classification, and are thus assumed to represent about equal annual supplies of nitrogen to the crop, this assumption must only be taken with the qualifications above stated.

In addition to the *nitrogen* we have of course in the nitrate its *soda*, in the ammoniacal salts sulphuric acid and chlorine, and in the rape-cake not only a considerable amount of carbon-yielding organic matter, but also a considerable amount of the mineral matters of the seeds from which the cake is made. The rape-cake, at least, must therefore be considered as providing, not only available *nitrogen*, probably in larger quantity than the other combinations, but *mineral matters* also. And it will, besides hese, yield a constant supply of carbonic acid, or other carbon products of transformation of its organic substance.

Besides the nitrate, the salts of ammonia, and the rape-cake, each used alone, the mixture of the ammoniacal salts, and also the rape-cake, were each used in conjunction with the respective mineral manures before described—namely the "*mixed alkalies*," the *superphosphate of lime*, and the mixture of the two.

Here, where the nitrate of soda was used in the larger quantity, as also where it was used in smaller amount (Experiment 7), it followed a mixture of sulphate of potash and superphosphate of lime, applied in the first year of the experiments (1852), but not since. What portion of the indicated superiority of the nitrate over the ammoniacal salts, whether used in the larger or the smaller quantity, may be due to this fact, unfortunately cannot be determined. On this point it may be noticed, that it was only in the later years of the experiments that the ammoniacal salts fell short of the nitrate in result. It was, therefore, only after an unusual exhaustion of the annually available minerals of the soil, by taking off a series of corn crops highly manured with available nitrogen, that the nitrate, following after supplied minerals, showed its superiority. Where the larger quantities were used, the average annual excess both of corn and straw by the nitrate over the ammoniacal salts was, however, considerably less than where the smaller amounts were employed. Again, as the nitrate in the larger quantity, gave almost identically the same average annual amounts both of corn and of straw as the rape-cake with its equal or larger amounts of nitrogen and abundant minerals, and as the equivalent amount of ammoniacal salts approaches nearer in result to the nitrate, and to the rape-cake with its minerals, than did the ammoniacal salts to the nitrate when used in smaller quantity—both of course, then, requiring much less minerals from the soil —we must judge, that part of the indicated superiority of the nitrate is really due to greater rapidity of its action; by which, both the underground and aboveground feeders of the plant were

constantly open to a larger area for the collection of nutriment, at each period of progression, than in the case of the ammoniacal salts.

A mere glance at the comparable experiments in the Series 3 and 4, shows how very small, especially in corn, was the increase obtained by the addition of a second 50 lbs. of ammonia, or its equivalent of nitrogen. In fact, its effect is in every instance much less than, and on the average only about half as great as, that of the first 50 lbs. This point we shall presently further illustrate by the aid of analysis. But the general fact should be clearly borne in mind in drawing comparisons among the individual experiments.

Going to actual figures, it is not a little remarkable that, as before alluded to, approximately equal amounts of nitrogen, indiscriminately in nitrate of soda, in ammoniacal salts, and in rape-cake, should over a period of five or six years, give us an average annual yield of corn so nearly identical. Thus the nitrate gave an average annual increase of 1081 lbs., the ammoniacal salts 1018 lbs., and the rape-cake 1079 lbs. corn. The nitrate and the rape-cake thus gave an average difference of only 2 lbs. per acre per annum of corn; the ammoniacal salts yielding about 60 lbs. less than either. In straw, the nitrate and rape-cake gave respectively an annual increase of 1772 and 1788 lbs., or the latter (the rape-cake) only 16 lbs. more than the former: the ammoniacal salts gave, however, about 340 to 350 lbs. less straw annually than the nitrate or the rape-cake. It is also worthy of remark, that, whilst the nitrate of soda and the rape-cake, when used alone, gave respectively 1081 and 1079 lbs. annual average of corn, the rape-cake with the superphosphate, as in Experiment 19, and with superphosphate and mixed alkalies, as in 20, gave almost identically the same amounts, namely, 1088 and 1077 lbs. Again, of straw, the nitrate and rape-cake alone, gave respectively 1772 and 1788 lbs. of annual increase, whilst the plots 19 and 20, with the same amount of rape-cake and the minerals, do not give 100 lbs. more—the amount being for the rape-cake and superphosphate 1872 lbs., and for the rape-cake, superphosphates, and mixed alkalies 1877 lbs. As there is no other point so nearly in common with these four different combinations as their amounts of nitrogen, there can be little doubt that their main or most characteristic effect upon the barley crop, was due to the available nitrogen they respectively supplied.

In calling attention to this very close coincidence in the result from a given amount of nitrogen supplied in different forms, it should at the same time be remarked, that the fact of the supply being in all these cases too heavy to allow of their full action and

the favourable ripening of the crop, should lead us to take the figures as only indicating a general equivalency, other things being equal, of nitrogen provided in these different forms. It has, indeed, already been shown to be probable, that the nitrate of soda, especially when not used in excess, may yield its quantum of produce more rapidly than ammoniacal salts; but evidence is yet wanting to enable us to decide, whether or not a given amount of nitrate supplied to the soil will really *eventually* yield a larger produce in proportion to its nitrogen. Further in reference to the above observed coincidence of result, it may be remarked that the amounts, though so far from the proportional increase obtained when nitrogen was used in smaller quantity, being still so nearly identical, affords some illustration of the absolute limit which *season* puts to the advantages of very high manuring. The facts next to be noticed will, indeed, show how contingent is the uniformity of action upon the influence of season on the progress and maturing of the crop.

In Experiment No. 15, as compared with No. 13, we see the influence of the addition of the "*Mixed Alkalies*" to the double amount of ammoniacal salts; and in No. 18, compared with No. 14, we see the effect of the "Mixed Alkalies" when added to rape-cake, containing an equal or larger amount of nitrogen. In both cases the average annual produce of corn, and consequently the increase, was less by about 160 lbs. than when the respective nitrogenous manures were used without these "Mixed Alkalies," the characteristic effect of which has been shown to be, rather to retard the ripening of the crop. The average produce of straw was, indeed, 121 lbs. more by the addition of the "Mixed Alkalies" to the ammoniacal salts; but as the deficiency of corn was more than this, the result is, that the average total produce is 41 lbs. less than by the ammoniacal salts alone. Again, the produce of straw, as well as that of corn, by the combination of the "Mixed Alkalies" and *rape-cake*, is considerably less than by the rape-cake alone—the deficiency being 159 lbs. corn, 158 lbs. straw = 317 lbs. total produce per acre per annum.

The superphosphate of lime, which, when added to the smaller amount of ammoniacal salts, gave an average annual increase over the produce of the ammoniacal salts alone of 354 lbs. corn. 636 lbs. straw = 990 lbs. total increase, gives, when added to the larger amount of these salts, only 172 lbs. more corn and 624 lbs. more straw; equal only 796 instead of 990 lbs. more total increase. The addition of the superphosphate of lime to the rape-cake, which latter already contained a liberal supply of other mineral constituents required by the growing barley, is very far less efficient still. By this combination we get only 9 lbs. more of corn and

84 lbs. more of straw, = 93 lbs. more of average total produce, than by the rape-cake alone.

The addition of both superphosphate of lime and "*Mixed Alkalies*" to the small amount of ammoniacal salts, increased the result by 405 lbs. of corn, 729 lbs. straw, = 1134 lbs. total increase; but their addition to the larger amount of ammoniacal salts only increased the produce by 198 lbs. corn, 882 lbs. straw, = 1080 lbs. total increase. The addition of the same full mineral manure to the rape-cake did very much less. Thus the combination gave 2 lbs. less corn and only 90 lbs. more straw than the rape-cake alone.

From all that has been said as to the very much increased luxuriance of growth where the double amounts of nitrogen were applied by manure, it will be sufficiently clear, that these apparently less results of both given amounts of nitrogen and of mineral manures, when the former—the nitrogen—was employed in so large an amount, was due in reality, not to the inaction of the manures, but to the over-luxuriance they induced in the earlier stages of growth, and the consequent falling of the crop and loss of final result. It is obvious, therefore, that the numerical results of Series 4, do not at all fairly represent the intrinsic productive values of the different combinations.

That over-luxuriance, and not the contrary, was the cause of the failure, is evident from the fact, that although the rape-cake used alone gave more increase than the ammoniacal salts alone, when they were respectively used with superphosphate of lime and superphosphate of lime and the "Mixed Alkalies" together (which increased the produce with smaller supplies of nitrogen), then the rape-cake, which when alone was the most active, gave less results than the ammoniacal salts.

The general conclusions from a review of the results of Series 4 are, that with an excessive amount of nitrogenous manure, the immediate return of crop from a given amount of the expensive manurial constituent—*available nitrogen*—will be much diminished; that the proportion of straw will be greater—an expensive end to which to devote such costly means; and lastly, that the addition under these circumstances of a liberal supply of certain otherwise effective mineral manures, may be quite inadequate to counteract the injurious effect; their tendency being then, as seasons go, still more to increase the straw in greater proportion than the corn.

From a review of the whole of the results relating to the action of special manures upon the barley-crop—taking the average of six successive years of growth by each, on land in an agricultural sense somewhat exhausted—we learn—

That exclusively mineral manures, and especially those containing phosphoric acid, annually increased the produce of barley; even doing so in the first year of their application on land in the condition described.

That with barley grown continuously on the same land (as was the case with wheat), nitrogenous manures had a much more striking effect than mineral manures.

That by the annual supply of nitrogenous manures alone (nitrate of soda or ammoniacal salts), larger successive crops both of corn and straw were obtained, than by the annual use of 14 tons of farmyard manure—with all its minerals, and certainly more nitrogen than either the nitrate or ammoniacal salts employed by its side.

That within certain limits, even on this comparatively exhausted soil (and it would probably be more nearly so on soils in ordinary condition for the crop), nitrate of soda, ammoniacal salts, and rape-cake, all increase the produce of barley, approximately in proportion to the amounts of nitrogen they respectively supplied. Their comparative effects will, however, vary somewhat according to season, the nitrate being generally more rapid in its action.

That to obtain a maximum amount of increase in proportion to the nitrogen given in manure, the barley-crop will, on the average of seasons, bear a considerably less acreage amount of it than is required by the wheat crop under similar circumstances.

That the effect of a given amount of nitrogen, if not excessive, will be considerably increased by the addition of certain mineral manures, especially those containing phosphates. The action of the mineral manures is very much increased under such circumstances; that is, their application gives very much more increase, when there is present a liberal supply of *available nitrogen within the soil*, than when there is not.

In other words, a soil brought by previous cropping into a condition to require manure of some kind before it will grow a full crop of corn, when afterwards cropped year after year with barley, only yields full crops when a liberal amount of nitrogen is supplied to the soil. Mineral manures, especially phosphates, considerably increase the action of the nitrogen so supplied; but the effect of such mineral manures on the increase of crop, will be extremely limited, without there be a liberal amount of *available nitrogen within the soil itself*.

The conclusions enumerated above have been arrived at by the consideration of experiments on the growth of barley by various constituents of manure, applied year after year on the same land. It will be interesting, with the information thus gained, to inquire

into the amounts of barley obtained in some of the same seasons, under very different, but also to a certain extent known conditions of growth, in other fields. By the comparisons that will thus be afforded, we shall get some useful check upon the conclusions hitherto arrived at. At the same time, so far as those conclusions are to be trusted upon their own independent evidence, they will, in their turn, serve to afford some insight into the comparative chemical conditions of soil, for exhaustion or otherwise, to which the results yet to be recorded are in all probability due. In this review we shall have perhaps still clearer evidence than has been already adduced, of how utterly unavailing is a liberal provision of the necessary mineral constituents in the soil to give even a moderate crop of barley, unless there be *at the same time, within the soil, available nitrogen.*

The first set of collateral experiments to be noticed is one in which barley was taken successively from the same land, in the seasons 1853, 1854, and 1855 respectively, after ten successive crops of turnips, which had been grown experimentally with different manures.

Accordingly, in Table XII. we have the produce of barley as under:—

1st. On a plot where turnips had been grown for ten years, and in the last seven without any manure whatever; the unmanured produce, leaf and bulb together, averaging little more than two tons per acre per annum.

2nd. On a plot, comprising several, which respectively had liberal supplies of different mineral manures only, every year during the last eight of the growth of the turnips. The produce of the turnips was here much greater than on the unmanured plot. On some portion of this and the following plots all, and on other portions only some, of the mineral constituents of the turnip-crop, were supplied each year in much larger quantity than they were taken off in the crops. The produce of the succeeding barley was, however, on all so very nearly alike, that only the mean produce over all, is here given.

3rd. On a plot which had had the same various mineral manures on different portions, as above, for the turnips; and in addition, during six years—1845 to 1850 inclusive—an average annual amount of about 44 lbs. of nitrogen per acre in the form of ammoniacal salts; after which the minerals only were applied for the two remaining years of roots.

4th. On a plot which had had the same set of mineral manures as Nos. 2 and 3 up to the end of the turnip experiments, and an average annual addition during the six intermediate years—1845 to 1850 inclusive—of about 95 lbs. of nitrogen in the form of

rape-cake; which, of course, further contained mineral matters and carbonaceous organic substance also.

5th. On a plot with the same mineral manures for the turnips as in Nos. 2, 3, and 4, and in addition during the six intermediate years—1845 to 1850 inclusive—an average annual supply of about 139 lbs. of nitrogen, given as a mixture of both rape-cake and ammoniacal salts.

It is not to our present purpose to discuss the relative amounts of turnips grown on these five different plots. But it may be stated generally, that the mineral manures alone, of No. 2, gave very much larger crops than the unmanured plot No. 1; and that the addition of the nitrogenous and other organic constituents to the mineral manures, as on Nos. 3, 4, and 5, always gave a further increment of increase. It should be added, however, that the produce by the six years' addition of nitrogenous manures did not, even in the eight years—that is, including the two which succeeded the application—return in either of the three cases the nitrogen in increase which had been supplied as manure. Where nitrogen was supplied in the manure for the turnips, we should therefore expect—unless it were evaporated or drained in some form from the soil, distributed too widely throughout it, fixed in it in an unavailable condition of combination, or in some way dissipated during the growth of the plant—that there would be some remaining available for the three succeeding crops of barley. Indeed the object of growing the barley three years in succession over these plots without any fresh manure, was to reduce them as far as possible to an equal condition as to available nitrogen, before commencing a new series of turnip experiments.

Before giving the Table of the produce of barley obtained in the three years—1853, 1854, and 1855—as above described, it should be further explained, that in the second year of barley (1854) a portion of the land, numbered 6 in the Table, which had the mineral manures only for the turnips, received in the second year of barley about 82 lbs. of nitrogen per acre in the form of ammoniacal salts; the barley following again in 1855, but without any further addition of nitrogen. Lastly, another portion with the mineral manures alone previously (No. 7 in the Table), received in the same year (1854), for the barley, about 82 lbs. of nitrogen in the form of nitrate of soda; and in the third year (1855) about 17 lbs. more nitrogen in the same form.

The produce of barley obtained after ten years' turnips on these seven plots is given in Table XII., which follows:—

TABLE XII.—EXPERIMENTS with BARLEY, GROWN after TURNIPS ten Years
for several Years

(Barn-Field

No.	DESCRIPTION OF MANURES FOR THE TURNIPS.
	Total Corn per
1	Unmanured since 1845
2	Mineral Manures only, since 1844
3	Mineral Manures, since 1844, and Ammoniacal Salts . 1845-50 inclusive (in all 263 lbs. Nitrogen)
4	Mineral Manures, since 1844, and Rape Cake . 1845-50 inclusive (in all = 568 lbs. Nitrogen)
5	Mineral Manures, since 1844, and Rape Cake, and Ammoniacal Salts . 1845-50 inclusive (in all = 831 lbs. Nitrogen)
6	Part of Mineral Plot, with 400 lbs. Ammoniacal Salts = 82 lbs. Nitrogen per Acre, in 1854
7	Part of Mineral Plot, with 550 lbs. Nitrate of Soda = 82 lbs. Nitrogen per Acre, in 1854 and with 112 lbs. Nitrate of Soda = 17 lbs. Nitrogen per Acre, in 1855
	Total Straw per
1	Unmanured since 1845
2	Mineral Manures only, since 1844
3	Mineral Manures, since 1844, and Ammoniacal Salts . 1845-50 inclusive (in all 263 lbs. Nitrogen)
4	Mineral Manures, since 1844, and Rape Cake . 1845-50 inclusive (in all = 568 lbs. Nitrogen)
5	Mineral Manures, since 1844, and Rape Cake and Ammoniacal Salts . 1845-50 inclusive (in all = 831 lbs. Nitrogen)
6	Part of Mineral Plot, with 400 lbs. Ammoniacal Salts = 82 lbs. Nitrogen per Acre, in 1854
7	Part of Mineral Plot, with 550 lbs. Nitrate of Soda = 82 lbs. Nitrogen per Acre, in 1854 and with 112 lbs. Nitrate of Soda = 17 lbs. Nitrogen per Acre, in 1855
	Total Produce (Corn and
1	Unmanured since 1845
2	Mineral Manures only, since 1844
3	Mineral Manures, since 1844, and Ammoniacal Salts . 1845-50 inclusive (in all 263 lbs. Nitrogen)
4	Mineral Manures, since 1844, and Rape Cake . 1845-50 inclusive (in all = 568 lbs. Nitrogen)
5	Mineral Manures, since 1844, and Rape Cake and Ammoniacal Salts 1845-50 inclusive (in all = 831 lbs. Nitrogen)
6	Part of Mineral Plot, with 400 lbs. Ammoniacal Salts = 82 lbs. Nitrogen per Acre, in 1854
7	Part of Mineral Plot, with 550 lbs. Nitrate of Soda = 82 lbs. Nitrogen per Acre, in 1854 and with 112 lbs. Nitrate of Soda = 17 lbs. Nitrogen per Acre, in 1855
	Dressed Corn per Acre—
1	Unmanured since 1845
2	Mineral Manures only, since 1844
3	Mineral Manures, since 1844, and Ammoniacal Salts . 1845-50 inclusive (in all 263 lbs. Nitrogen)
4	Mineral Manures, since 1844, and Rape Cake . 1845-50 inclusive (in all = 568 lbs. Nitrogen)
5	Mineral Manures, since 1844, and Rape Cake and Ammoniacal Salts 1845-50 inclusive (in all = 831 lbs. Nitrogen)
6	Part of Mineral Plot, with 400 lbs. Ammoniacal Salts = 82 lbs. Nitrogen per Acre, in 1854
7	Part of Mineral Plot, with 550 lbs. Nitrate of Soda = 82 lbs. Nitrogen per Acre, in 1854 and with 112 lbs. Nitrate of Soda = 17 lbs. Nitrogen per Acre, in 1855
	Weight per Bushel of Dressed
1	Unmanured since 1845
2	Mineral Manures only, since 1844
3	Mineral Manures, since 1844, and Ammoniacal Salts . 1845-50 inclusive (in all 263 lbs. Nitrogen)
4	Mineral Manures, since 1844, and Rape Cake . 1845-50 inclusive (in all = 568 lbs. Nitrogen)
5	Mineral Manures, since 1844, and Rape Cake and Ammoniacal Salts 1845-50 inclusive (in all = 831 lbs. Nitrogen)
6	Part of Mineral Plot, with 400 lbs. Ammoniacal Salts = 82 lbs. Nitrogen per Acre, in 1854
7	Part of Mineral Plot, with 550 lbs. Nitrate of Soda = 82 lbs. Nitrogen per Acre, in 1854 and with 112 lbs. Nitrate of Soda = 17 lbs. Nitrogen per Acre, in 1855

* In these cases the Total and Average Annual *Produce* are given for two years only ; and the

succession, which were manured with the same kind of Manure on the same Plot consecutively.

Rothamsted, Herts.)

Produce per Acre.					Increase per Acre, by Manure.		
1853.	1854.	1855.	Total.	Average Annual.	Total.	Average Annual.	
Acre—in lbs.							
1149	1012	1016	3177	1059			
1185	1077	1078	3340	1113	163	54	Over Unmanured.
1324	1167	1154	3645	1215	305	102	Over Mineral Manures.
1648	1388	1303	4339	1446	999	333	Over Mineral Manures
1665	1338	1282	4285	1428	945	315	Over Mineral Manures.
..	2998	1424	* 4422	* 2211	* 2267	* 1133	Over Mineral Manures (2 years).
..	3224	2268	* 5492	* 2746	* 3337	* 1668	Over Mineral Manures (2 years).
Acre—in lbs.							
1508	1530	1156	4194	1398			
1433	1397	1128	3958	1319	236	79	Less than Unmanured.
1540	1524	1177	4241	1414	283	94	Over Mineral Manures.
1910	1783	1409	5102	1701	1144	381	Over Mineral Manures.
1881	1798	1273	4952	1651	994	331	Over Mineral Manures.
..	4379	1428	* 5807	* 2903	* 3282	* 1641	Over Mineral Manures (2 years)
..	4781	2459	* 7240	* 3620	* 4715	* 2357	Over Mineral Manures (2 years)
Straw) per Acre—in lbs.							
2657	2542	2172	7371	2457			
2618	2474	2206	7298	2432	73	25	Less than Unmanured.
2864	2691	2331	7886	2629	588	196	Over Mineral Manures.
3558	3171	2712	9441	3147	2143	714	Over Mineral Manures.
3546	3136	2555	9237	3079	1939	646	Over Mineral Manures.
..	7377	2852	* 10,229	* 5114	* 5549	* 2774	Over Mineral Manures (2 years).
..	8005	4727	* 12,732	* 6366	* 8052	* 4026	Over Mineral Manures (2 years).
in Bushels and Pecks.							
20 0¼	17 3¼	19 0	56 3½	18 3¾			
20 1¾	19 2	19 3¾	59 3½	19 3¾	3 0	1 0	Over Unmanured.
23 0¼	21 0¾	21 2¼	65 3¼	22 0	6 0¼	2 0	Over Mineral Manures.
28 2¾	24 2½	23 3½	77 0¼	25 3	17 1¼	5 3	Over Mineral Manures.
29 0½	23 3¼	23 3	76 2¼	25 2¼	16 3¼	5 2½	Over Mineral Manures.
..	52 1¼	26 2¼	* 78 3½	* 39 1¾	* 39 1¾	* 19 2¾	Over Mineral Manures (2 years).
..	54 3¼	40 1½	* 95 0¼	* 47 2¼	* 55 3	* 27 3½	Over Mineral Manures (2 years).
Corn—in lbs. and tenths.							
53·00	53·25	51·00	..	52·42			
53·20	53·40	51·97	..	52·86			
52·87	53·46	51·60	..	52·64			
52·22	53·85	51·88	..	52·65			
52·61	53·84	51·88	..	52·78			
..	54·29	52·19	..	53·24			
..	53·51	53·04	..	53·27			

Total and Average Annual *Increase* also, are calculated only for the two corresponding years.

Taking together the results relating to the continuous growth of barley in Hoos-field, given in former tables, and those here given in Table XII., we have the means of comparing the produce of barley obtained without manure during three years in succession, after a series of unmanured turnip crops, with that obtained in the same seasons without manure, on land of very similar intrinsic character; but which, differed widely in the *condition* induced by the very different cropping, &c., to which it had been submitted. Next, confining attention to the results of three years' barley after ten years' turnips (in Table XII.), we have, taking the produce after the *unmanured* turnips as the standard of comparison, the means of judging of the effects on the succeeding barley, of an enormous excess of mineral manures annually applied for the previous turnip crops. Compared with the produce of barley obtained after this large residue of mineral manures—by this time, no doubt, considerably distributed through the soil—we can trace the increase due to any available residue of nitrogen, where it was added in the different forms to the mineral manures for the turnips. Lastly, by the effects of the direct addition of nitrogenous manures for the barley (as in Nos. 6 and 7), to the residual high mineral condition, we can judge, whether or not, any deficiency of the crop on the other plots was probably attributable to a want of *available nitrogen within the soil.*

If the characteristic influence of a *rotation of crops*, upon the increased growth of the cereals, be at all materially due to the elaboration in the soil, during the growth of other crops, of the necessary mineral supplies for the white crop, it might surely be expected that here, after ten meagre, unmanured crops of turnips, appropriating no amount of silicates, we should have, if ever it were possible, a large produce of barley, depending, with these rich stores of prepared mineral food in the soil, upon atmospheric sources for its nitrogen? If not after the many crops of *unmanured* turnips, surely after those provided with a very large excess of other mineral matters than silicates—the crop taking none of the latter out—we should have enough elaborated and conserved in the soil both of these and of all other mineral constituents, to yield the fullest crop of barley which it is possible to obtain by the conjoint influence of a very rich mineral condition of soil, and the normal season supplies of available nitrogen? What is the result?

In the following Table (XIII.), is afforded a summary view of the produce of barley without manure for the three years in question, in Hoos-field, devoted to the experiments on the continuous growth of barley by different manures, side by side with that

obtained after many successive turnip crops, which had been respectively grown without manure, and with an excessive supply of mineral manures :—

TABLE XIII.

PRODUCE of UNMANURED BARLEY, in the continuous SERIES in HOOS-FIELD, compared with that after many Crops of Turnips either Unmanured or with Mineral Manures.

	Produce of Barley per Acre.					Increase, or Loss, per Acre.	
	1853.	1854.	1855.	Total (3 Years.)	Average Annual.	Total (3 years.)	Average Annual.
Dressed Corn per Acre, in Bushels and Pecks.							
	bsh. pk.	bsh. pk.	bsh. pk.	bsh. pk.	bsh. pk.	bsh. pk.	bsh. pk.
Hoos-Field—Unmanured Plots	26 3	34 1	34 3¼	95 3¼	31 3¾		
Barn-Field { After Unmanured Turnips . .	20 0¼	17 3¼	19 0	56 3½	18 3¾		
Barn-Field { After Mineral-manured Turnips	20 1¾	19 2	19 3¾	59 3½	19 3¾	3 0	1 0
Total Corn, per Acre, lbs.							
Hoos-Field—Unmanured Plots	1547	1940	1934	5421	1807		
Barn-Field { After Unmanured Turnips . .	1149	1012	1016	3177	1059		
Barn-Field { After Mineral-manured Turnips	1185	1077	1078	3340	1113	163	54
Total Straw, per Acre, lbs.							
Hoos-Field—Unmanured Plots	1865	2395	1934	6194	2065		
Barn-Field { After Unmanured Turnips . .	1508	1530	1156	4194	1398		
Barn-Field { After Mineral-manured Turnips	1433	1397	1128	3958	1319	—236	—79
Total Produce (Corn and Straw) per Acre, lbs.							
Hoos-Field—Unmanured Plots	3412	4335	3868	11615	3872		
Barn-Field { After Unmanured Turnips . .	2657	2542	2172	7371	2457		
Barn-Field { After Mineral-manured Turnips	2618	2474	2206	7298	2432	—73	—25

Comparing the produce of barley on the unmanured plots in the two fields, and without going into the detail of the separate years, it is seen that, although in the field of continuous barley experiments, there was an annual average produce over the three years, of 31 bushels 3¾ pecks of dressed corn, or 1807 lbs. total corn, there were, after the ten meagre crops of turnips, only 18 bushels 3¾ pecks of dressed, and 1059 lbs. of total corn. Of straw, the average annual yield for the three years was 2065 lbs. in the field of continuous barley, and only 1398 lbs. after the turnips. We have then, less than two-thirds as much corn, and just about two-thirds as much straw, after the ten years' turnips, as in the field whence much more corn had been recently taken. In fact, a produce of scarcely 19 bushels per acre per annum of

barley corn, and little more than half a ton of straw—together equal to not a ton of dry substance of produce—must be admitted to be exceedingly small. The *condition* of the land after ten successive crops of turnips, must have been, for barley growth, at the lowest possible point.

That a liberal supply of mineral constituents distributed through the soil, cannot restore this exhausted fertility, is seen by the produce of barley after the mineral-manured turnips. After ten years of turnips, the last eight of which were grown by excessive supplies of mineral manures, we have an annual average of 54 lbs., or 1 bushel of corn more, and 79 lbs. of straw less, = 25 lbs. *less total produce*, than after the unmanured turnips.

In what constituent or constituents had these unmanured and mineral-manured turnips exhausted the soil, in so far as the after production of barley was concerned, to a point even far below that arrived at in the other field by the previous growth of one crop of wheat, one crop of barley with sulphate of ammonia, and one crop unmanured—that is, three white straw crops in succession without mineral manure? An examination of Table XII. will throw some light on this point.

It has already been said, that there was an average annual increase of 54 lbs. of corn, but a decrease of 25 lbs. total produce, where the barley succeeded the mineral-manured turnips, compared with the produce after the unmanured turnips. Taking now the produce after the *mineral-manured* turnips as the standard of comparison, there was, where in the six middle years of the ten of turnips ammoniacal salts had also been applied, an annual average increase in the succeeding barley of 102 lbs. corn, and 94 lbs. straw, = 196 lbs. total produce.

Still comparing with the produce after the mineral-manured turnips, we have, where in six years out of the ten rape-cake was employed in addition to the minerals, an average annual increase of succeeding barley, of 333 lbs. corn, and 381 lbs. straw,=714 lbs. total produce.

Lastly, where during six years both ammoniacal salts and rape-cake were added to the mineral manures for the turnips, the succeeding barley gave an annual average increase of 315 lbs. corn, and 331 lbs. straw, = 646 lbs. total produce.

We had then, with a residue in the soil of merely mineral manures, even a loss of produce of barley—due to a greater growth, and consequent greater exhaustion of other matters, by the turnip. We find, on the other hand, a perceptible gain in the barley wherever the turnips had received either ammoniacal salts or rape-cake as well as the mineral manures. Even here, however, the produce, with this nitrogenous and full mineral residue

in the soil, was not equal to the annual unmanured produce in the other field, where the barley was growing continuously.

That the beneficial effect of the residue of the rape-cake was not due to the mineral constituents it supplied, may be judged by the fact, that the residue of the direct mineral manures had not any such effect. It was undoubtedly a residue of *available nitrogen within the soil*, that gave the increase of produce of barley where the ammoniacal salts or rape-cake had been employed for the turnips. If this be admitted, we have in the facts, at once a beautiful illustration of the degree of reliance upon nitrogen in the soil of the turnip crop, and of the utter incapability of rich supplies of mineral constituents in the soil, to be of any avail in yielding agricultural quantities of barley, unless there be at the same time *within the soil*, a liberal amount of *available nitrogen.*

If further proof be wanted that the necessary mineral constituents were in abundance, and available in this turnip-exhausted soil for very full crops of barley, provided only available nitrogen were also within the reach of the roots of the plants, it is to be found in the results of the experiments Nos. 6 and 7 (Table XII.). Here ammoniacal salts and nitrate of soda respectively, were added to a part of the turnip plot, where the residue of the turnip mineral manures alone, had been unavailing to increase the produce of barley.

In 1853 the produce of barley on the mineral-manured turnip-plots was $20\frac{1}{2}$ bushels. In 1854 those portions of the mineral-manured plots left without further manure gave $19\frac{1}{2}$ bushels. But where now (in 1854), about 82 lbs. of nitrogen per acre were added as ammoniacal salts, we had, instead of $19\frac{1}{2}$ bushels, $52\frac{1}{2}$ bushels of barley; and where the same quantity of nitrogen was added as nitrate of soda, $54\frac{3}{4}$ bushels. The increase in the produce of straw was in greater proportion still. By the addition of the ammoniacal salts, the straw was raised from 1397 lbs. per acre to 4379 lbs.; and by the nitrate of soda it was increased to 4781 lbs. The total produce (corn and straw together), was thus from 3 to $3\frac{1}{2}$ times as great by the simple addition of ammoniacal salts or nitrate of soda. And it may be observed, in passing, that here again nitrate of soda was more active than an assumed equal amount of nitrogen given as ammoniacal salts.

It is very remarkable too, that although the produce after the mineral-manured turnips was little more than half as much as the unmanured produce in the field of continuous barley experiments, yet the addition of a given amount of nitrogen gave very nearly identical results in both fields. Thus, after the mineral-manured turnips, we had, with the ammoniacal salts and nitrate of soda respectively, 7377 lbs. and 8005 lbs. of total produce (corn and straw together); and in the field of continuous barley

experiments we had, with the same amount of nitrogen, given as ammoniacal salts (without minerals), 7548 lbs., and as nitrate of soda (second year without minerals), 7400 lbs. of total produce. Again, in the same field of continuous barley experiments, the mean result of direct mineral manures and ammoniacal salts together, was 8320 lbs.; and that of even more nitrogen given as rape-cake (itself supplying also mineral constituents, as well as carbonaceous organic matter), with, in 3 out of 4 cases, direct mineral manures also, was 8150 lbs.

In the contrasts and coincidences afforded by the results in these two fields, we have the clearest evidence, that it was in *available nitrogen* for the barley crop, that the previously mineral-manured turnip soil had become deficient, as compared with the unmanured land in the field of continuous barley experiments. It is evident moreover, that on the mineral-manured turnip plots there was an abundant provision of the requisite mineral constituents for an exceedingly full crop, within the reach of the barley plant, provided only *available nitrogen*, were also within the reach of its roots. Lastly, with the widely-differing condition of the land in the two fields without further nitrogenous manure, and the approximation to equal amounts of produce, when, with comparable other conditions, both are supplied with a full dressing of such manure, again we learn, how marked is the influence of season on the productive effects of our most active manures.

With the further light upon the "*condition*" of soil required by the barley crop, which the examination of the produce obtained after ten years of turnips, and its comparison with that in the other field, affords, we will now examine the results obtained in still another field, under circumstances differing widely from those of either of the other two.

The field now to be spoken of, immediately adjoins the one where the barley succeeded ten years of turnips, as last under notice. In 1848 three portions of nearly an acre each were set apart for separate experiments on the chemical statistics of *rotations of crops.*

For all three of these portions of land the rotation chosen was —turnips, barley, clover, wheat. When the second course of clover came round, after a lapse of only four years, it, as was to be expected, failed; and hence, half of each plot was sown with beans, and the other half fallowed instead. None of the crops were to be manured excepting the turnips, which commenced each course.

The plot devoted to *Rotation No.* 1 was to remain entirely unmanured—even the turnips—course after course.

The turnips of each course, of *Rotation No.* 2, were to be manured with superphosphate of lime alone.

The turnips of *Rotation No.* 3 were, each time they came round, to be manured with superphosphate of lime, the sulphates of potash, soda, and magnesia, 2000 lbs. rape-cake, and 100 lbs. each sulphate and muriate of ammonia, per acre.

We have here, therefore, three parallel rotations with the same crops—the one with no manure whatever, course after course; a second with superphosphate of lime alone once in four years; and a third with, after the same interval, a mixed manure, supplying liberally to the soil phosphates and other mineral constituents, and both nitrogen and carbonaceous organic substance.

As each of these three four-course rotation experiments has been in progress since 1848, they have each afforded us three barley crops, after turnips respectively so variously manured; namely, in 1849, in 1853, and 1857. And, as from half of each turnip plot, the entire produce, leaf and bulb, was carted off, and on the other half the roots were eaten by sheep, and the leaves distributed over the land, we have the produce of the barley on each turnip plot subdivided, so as to show the comparative effects on each, of the drawing off and folding.

Without going into any lengthened detail regarding any other crops of these rotations than the barley, it may be stated generally, that the turnips grown by the full mixed manure, averaged over 20 tons each course, of entire produce, leaf and bulb together; the crop of the last course was, however, rather the smallest of the three. The superphosphated turnips gave an average per course of 13 to 14 tons leaf and bulb, the first crop being some tons above, and the last some below that amount. The unmanured turnips again, gave an average of 4 to $4\frac{1}{2}$ tons per course, leaf and bulb. But whilst the first unmanured crop amounted to from 9 to 10 tons, the second and third did not reach 2 tons each of total produce. It need only be further remarked, that as there was a much greater falling off in each succeeding turnip crop where it was unmanured, or received only superphosphate of lime, than where there was a full manuring each course, it may be judged that the soil contained a larger unexhausted residue of available constituents from previous cropping, &c., at the commencement of the first course, than at that of the others.

Table XIV., which follows, gives the produce of barley, in each of the three courses, of each of these three differently-manured rotations. It is also in each case given separately for the portions where the turnips were respectively carted off, or eaten on the land.

TABLE XIV.—EXPERIMENTS with BARLEY Grown in FOUR-COURSE ROTATIONS, commencing with ROOTS differently MANURED, the same Manures being employed on the same Land for the Roots of the three successive Courses of each Rotation.

(Agdell-Field, Rothamsted, Herts.)

	ROTATION, No. 1. Each Course entirely Unmanured.			ROTATION, No. 2. Each Course commencing with Superphosphate of Lime, alone, for the Root Crop.			ROTATION, No. 3. Each Course commencing with Superphosphate of Lime, "Mixed Alkalies," Ammoniacal Salts, and Rape Cake, for the Root Crop.		
	After Turnips Carted off.	After Turnips Fed on Land.	Increase or Loss by folding.	After Turnips Carted off.	After Turnips Fed on Land.	Increase or Loss by folding.	After Turnips Carted off.	After Turnips Fed on Land.	Increase or Loss by folding.
Total Corn per Acre—Lbs.									
Barley of 1st Course—Season, 1849	2681	2734	53	1676	2526	850	1943	2569	626
Barley of 2nd Course—Season, 1853	1947	1930	—17	1875	2341	466	2262	2279	17
Barley of 3rd Course—Season, 1857	2592	2482	—110	1727	2846	1119	2712	3608	896
Mean of the 3 Barley Crops .	2407	2382	—25	1759	2571	812	2306	2819	513
Total Straw per Acre—Lbs.									
Barley of 1st Course—Season, 1849	2992	3182	190	1989	3264	1275	2463	3674	1211
Barley of 2nd Course—Season, 1853	2309	2221	—88	2023	2743	720	2599	3152	553
Barley of 3rd Course—Season, 1857	2465	2430	—35	1545	2687	1142	2417	3487	1070
Mean of the 3 Barley Crops .	2589	2611	22	1852	2898	1046	2493	3438	945
Total Produce (Corn and Straw) per Acre—Lbs.									
Barley of 1st Course—Season, 1849	5673	5916	243	3665	5790	2125	4406	6243	1837
Barley of 2nd Course—Season, 1853	4256	4151	—105	3898	5084	1186	4861	5431	570
Barley of 3rd Course—Season, 1857	5057	4912	—145	3272	5533	2261	5129	7095	1966
Mean of the 3 Barley Crops .	4995	4993	—2	3612	5469	1857	4799	6256	1457
Dressed Corn per Acre, in Bushels and Pecks.									
Barley of 1st Course—Season, 1849	45 0¼	46 2	1 1¾	28 3	41 3¼	13 0½	32 3½	42 3¾	10 0½
Barley of 2nd Course—Season, 1853	33 1	32 1¼	—0 3¾	31 3¼	38 3½	6 3¾	38 0¼	36 1	—1 3¼
Barley of 3rd Course—Season, 1857	46 0½	44 1	—1 3½	30 3	50 2½	19 3½	47 3¼	64 3¼	17 0½
Mean of the 3 Barley Crops .	41 2	41 0¼	—0 1¾	30 2	43 3	13 1	39 2¼	48 0	8 1¾
Weight per Bushel of Dressed Corn—Lbs. and Tenths.									
Barley of 1st Course—Season, 1849	56·7	56·8	0·1	56·7	57·6	0·9	57·2	57·5	0·3
Barley of 2nd Course—Season, 1853	52·3	52·6	0·3	52·9	51·9	—1·0	52·8	51·3	—1·5
Barley of 3rd Course—Season, 1857	54·2	53·7	—0·5	54·1	54·0	—0·1	54·7	54·4	—0·3
Mean of the 3 Barley Crops .	54·4	54·4	0·0	54·6	54·5	—0·1	54·9	54·4	—0·5
Proportion of Total Corn, in 100 Total Produce.									
Barley of 1st Course—Season, 1849	47·3	46·2	—1·1	45·7	43·6	—2·1	44·1	41·1	—3·0
Barley of 2nd Course—Season, 1853	45·7	46·5	0·8	46·5	46·0	—0·5	46·5	42·0	—4·5
Barley of 3rd Course—Season, 1857	51·2	50·5	—0·7	52·8	51·4	—1·4	52·9	50·8	—2·1
Mean of the 3 Barley Crops .	48·1	47·7	—0·4	48·3	47·0	—1·3	47·8	44·6	—3·2
Proportion of Dressed Corn, in 100 Total Corn.									
Barley of 1st Course—Season, 1849	95·5	96·6	1·1	97·4	95·3	—2·1	96·9	96·2	—0·7
Barley of 2nd Course—Season, 1853	89·4	88·1	—1·3	90·1	86·3	—3·8	88·9	81·5	—7·4
Barley of 3rd Course—Season, 1857	96·5	95·8	—0·7	96·3	96·1	—0·2	96·3	97·9	1·6
Mean of the 3 Barley Crops .	93·8	93·5	—0·3	94·6	92·6	—2·0	94·0	91·9	—2·1

The figures in Table XIV. deserve a careful examination by the reader. Our space will only allow us to call special attention to one or two points of prominent interest. To aid us in this, we subjoin in Table XV., given below, a summary statement of the produce of barley obtained where the turnips were carted off in the unmanured rotation, by the side, when at command, of the unmanured produce, in the same years, in the other two fields:—

TABLE XV.

HISTORY OF THE LAND.	Produce of Barley, Unmanured.		
	1849.	1853.	1857.
Dressed Corn per Acre, in Bushels and Pecks.			
	bsh. pk.	bsh. pk.	bsh. pk.
Agdell-Field—In four-course Rotation after Turnips Unmanured and Carted off	45 0¼	33 1	46 0½
Hoos-Field —In continuous Barley Series		26 3	30 1¼
Barn-Field —After 10 crops of Turnips Carted off (8 Unmanured)		20 0¼	
Total Corn per Acre, lbs.			
Agdell-Field—In four-course Rotation after Turnips Unmanured and Carted off	2681	1947	2592
Hoos-Field —In continuous Barley Series		1547	1679
Barn-Field —After 10 crops of Turnips Carted off (8 Unmanured)		1149	
Total Straw per Acre, lbs.			
Agdell-Field—In four-course Rotation after Turnips Unmanured and Carted off	2992	2309	2465
Hoos-Field —In continuous Barley Series		1865	1604
Barn-Field —After 10 crops of Turnips Carted off (8 Unmanured)		1508	
Total Produce (Corn and Straw) per Acre, lbs.			
Agdell-Field—In four-course Rotation after Turnips Unmanured and Carted off	5673	4256	5057
Hoos-Field —In continuous Barley Series		3412	3283
Barn-Field —After 10 crops of Turnips Carted off (8 Unmanured)		2657	

The first point of observation brought prominently to light by this summary Table is, that the produce of barley obtained in *rotation*, even when the turnips were both unmanured and carted off, was considerably greater than when the crop was grown annually in succession on the same land. This too was even more strikingly the case in the third unmanured course than previously. It has been already seen that the barley obtained continuously in succession, was, on the other hand, considerably more than that after a series of unmanured turnip crops.

Bearing in mind the point last mentioned, and now referring to Table XIV., it is interesting to observe, that in each of the three seasons of barley in rotation, the produce was considerably less after the carted-off turnips grown by superphosphate of lime, than after those without any manure whatever. After what has already been gathered of the nitrogen-exhausting characters of the

turnip, this result is easily explained by the fact, that much larger crops of turnips were in each course taken from the superphosphated, than from the unmanured rotation land. Consistently with this (omitting the first course when the existing *condition* of the land obviously somewhat interfered with the result in all three rotations), it is on the other hand seen, that the *fed* superphosphated turnips gave larger succeeding crops of barley than the *fed* unmanured ones.

It is worthy of remark, that on the entirely unmanured rotation plot, the barley after the fed-on-turnips was, in the last two courses, when the turnips had amounted to less than 2 tons per acre total produce, even somewhat less than where the corresponding crops of roots had been carted from the land. This was possibly due to more injury being done to the texture of the land by the treading of the sheep, than was compensated by the trifling amount of manure from the consumption of such meagre crops of turnips.

In the case of the full manured turnips, as well as the superphosphated ones, there was, however, always a considerable increase in the succeeding barley by feeding the turnips on the land. As was to be expected, too, the barley after the highly manured turnips, whether carted off or fed on the land, was always heavier than after the corresponding superphosphated ones. On the other hand, the difference in the amount of barley depending on whether the turnips were fed on the land or removed, was considerably greater where the superphosphate of lime alone was employed for the roots. This was partly due, as already implied, to the fact that the removed superphosphated turnips had drawn from the land more of certain constituents not supplied in manure, and therefore left the soil poorer in them for the succeeding barley, than where the full manure, or even no manure whatever (with the consequent meagre turnip crops), was employed. But as there was evidence that, where the highly manured turnips had been fed on the land, it was in too high a condition to yield, as seasons go, so full an amount of produce in proportion to the manure as when the latter was less in quantity, it is obvious that the difference in result by feeding, would be more striking after the superphosphated turnips—where by carting-off the exhaustion was greater, and by folding the manuring was not too high—than where, as on the highly manured plot, both the exhaustion by the removal of the turnips was less, and the manuring by feeding was more excessive. Here again, it may be remarked in passing, the figures teach us how sensitive is the barley crop to the vicissitudes of season, and how liable to injury under them, when manured beyond a certain somewhat narrow limit.

Let us now for a moment review as a whole, the various field experiments on the growth of barley. It has been found, that the amount of produce when grown after a succession of removed unmanured, or even highly mineral-manured turnip crops, was far below a moderate agricultural yield. It was seen, that by the simple addition of nitrogenous manure to land in this condition, enormous crops were raised. When barley was grown without manure year after year, on land in a less artificially exhausted condition than that where ten successive turnip crops had been grown, the produce was considerably greater than after the succession of turnip crops. On this land mineral manures somewhat increased the produce. But, as on the turnip-exhausted land, nitrogenous manures did so much more strikingly. In both fields, indeed, the amount of available nitrogen supplied to the soil, ruled the amount of produce very much more strikingly, than did the supply of the necessary mineral constituents of the crop. In growing barley in *rotation*, on land previously brought to that comparative state of exhaustion, in which, under ordinary cultivation with home manuring and ordinary cropping, the conclusion of a course will leave it, the unmanured produce of barley throughout three subsequent courses of an entirely unmanured rotation, was considerably greater than that where barley was grown year after year; and it was still further in excess of that obtained after a series of unmanured turnip crops.

Here then is a striking effect upon the produce of barley by growing it in a *rotation*—even unmanured—of turnips, barley, clover, wheat. When the turnips in such a rotation were grown by superphosphate of lime, and by it larger crops of the roots removed than without manure, the produce of barley was less than after the unmanured turnips. Here too, then, the produce of barley is diminished after unusual exhaustion by turnip cropping. But either the consumption of the superphosphated turnips on the land, the residue of a mixed mineral and nitrogenous manure after turnips grown by it had been carted off, or the consumption of these turnips on the land, greatly increased the subsequent produce of barley above that of the turnip exhausted rotation land. It could certainly not be the restoration of mineral matters, to which, in these cases the increased produce of barley was mainly due; for the increase was greater by the consumption on the land of the merely superphosphated turnips, than by the residue of far richer mineral (and organic) manure where the turnips grown by it had been removed, taking away but a small proportion of the supplied minerals; and it was greater still where these highly manured turnips were fed on the land, and returned to it a considerable amount of nitrogen, in addition to the already relative excessive amount of minerals.

It was seen too, in the other fields, that mineral manures were quite unavailing to give even moderate crops of barley, unless there were *available nitrogen within the soil.*

It may fairly be concluded, that a characteristic effect of alternating the other crops with the barley, has been to leave more available nitrogen from some source, within the reach of the roots of the latter, than when either this same crop was grown continuously in succession, or when a number of successive turnip crops were previously removed from the land. Barley then, like wheat, requires characteristically what may be termed a nitrogenous *condition* of soil. It cannot, however, under ordinary circumstances, bear such large amounts of nitrogen supplied as wheat; though what it does require, from the habit of the plant, and its usual limited period of growth, should be more confined to the upper layers of soil. For these reasons, barley may often be taken with advantage after a previous white crop, by a spring-dressing merely, of chiefly nitrogenous manure. In such cases the direct addition of mineral manures, especially those containing phosphates, will have a more striking effect than upon the *winter-sown wheat.* The effect of such mineral manures is not only to increase the general growth, but to bring the crop more rapidly to maturity. The more frequent alternative is, that barley is taken after a root-crop, in part, or entirely, fed on the land. The appropriateness of this course for barley rather than for wheat, besides the advantage arising from the season of the year at which the land is generally clear for the corn, rests mainly on the fact, that the manure by folding, with the subsequent light working of the land, is more confined to the superficial layers of soil, in which comparatively, the roots of the barley play more freely.

A disadvantage of growing barley after the folding of sheep on turnips is, that with high farming the land is apt to be thus left in too high a condition for the crop to succeed well in the average of seasons; whilst, on the heavier lands, there is frequently much injury done to the texture, rendering it difficult to get the fine tilth so essential to the favourable growth of barley.

Of direct portable manures for barley, Peruvian guano, or salts of ammonia, or nitrate of soda—either of them with a small quantity of superphosphate of lime—are the best. Rape-cake is also a good manure for barley, but it is generally too high in relative price. These manures, as well as purely mineral manures, are most advantageously applied before, or at the time of sowing, so as to be somewhat distributed through the surface soil by the mechanical operations. As a mere top-dressing nitrate of soda is the best. Of the more exclusively nitrogenous manures—salts of ammonia and nitrate of soda—the nitrate acts somewhat

more rapidly for a given amount of nitrogen supplied. The action of the purely nitrogenous manures, is economised by admixture with a small quantity of superphosphate of lime, or other appropriate mineral manure. Other things being equal, the later the barley is sown, the less should be the proportion of nitrogen in the manure, and the greater that of mineral constituents; otherwise the crop is liable to be too luxuriant; and with a limited range of root in the soil, it will probably not find mineral constituents rapidly enough in the later stages of growth, for a favourable development and maturing of the seed.

By the concurrent testimony of field experiments of very various kinds, we have been led to the conclusion that full crops of barley cannot be grown unless there be, by some means, available nitrogen provided within the soil. It happens that in practice it is frequently convenient to increase the produce of the barley crop by the direct application of portable nitrogenous manures. It is very desirable, therefore, both in a practical and scientific point of view, to have some means of judging of what is the probable proportion of the nitrogen so supplied in manure, which will, on the average, or under given circumstances, be recovered in the immediate or successive increase of crop obtained. We propose, therefore, to adduce such evidence on these points as, by the aid of analysis, we are enabled to provide.

Before passing to this concluding division of the subject, however, it may be well to add a few words on the more marked effects of direct mineral manures on the barley than on the wheat crop. That such should be found to be the case is seen to be quite consistent, on a consideration of the distinctive habits and usual circumstances of growth in our rotations, of these two, nevertheless much allied crops.

The necessity of considering the various habits and conformation of the different crops of our rotations in relation to their resources of growth, was prominently insisted upon in our early papers in this Journal ten years ago. The important bearing of such considerations in modifying the conclusions, to which a more purely chemical view of the offices and province in a system of manuring of the various constituents would lead, is one of the first lessons which the progress of field experiments teaches. Indeed, in the early years of our own experiments, so desirable did it seem, to verify and define the more obvious conclusions of superficial observation on some of the points herein involved, that the summer of 1846 was devoted mainly to the examination of the comparative underground ranges of the various crops of our rotations. The comparatively great depth and extent to

which several of the leguminous crops (especially clover)—and also wheat and oats—penetrated, was very remarkable. It may be mentioned in passing, that of the specimens traced out in the experiments then made, one clover plant was for a length of time preserved with roots nearly 6 feet in length, the successful extrication of which, through their numerous wendings, was the result of the tedious labour of many days. It is to be regretted that the perfect series of specimens was not preserved as such, or at least perpetuated by drawings as a means of useful illustration for others.

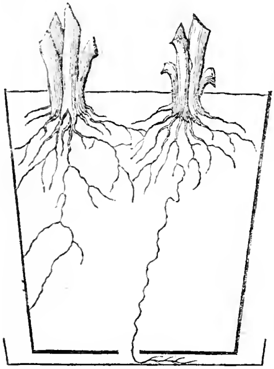
But to recur: when considering the results of field experiments on wheat, we have directed attention to the fact, that the success of the autumn-sown crop was greatly dependent upon the progress of the under-ground development during the early months of growth. It was held that this was very much favoured, other things being equal, by a liberal supply of available nitrogen within the soil, and that thus, the range of collection of the fibrous feeders of the plant was so extended as to render available, when needed in the after stages of growth of the plant, the mineral constituents of a much larger area of the soil, than otherwise would be the case. Very different are the usual conditions of the growth of barley. Instead of winter-growth, and a compressed soil, tending to increased depth and area of root distribution, we sow our barley in the spring, work the staple shallow, and keep it as light and open as possible. Under these circumstances of short time, rapid growth, and comparatively limited depth and area of root development, we find the direct supply of some of the rarer, but essential mineral constituents of our soils, much more efficient with the barley crop than with wheat.

The mechanical conditions of soil, and the season of growth of the barley crop, are in many respects more like those required by the turnip; and they are calculated to favour the distribution of a large amount of fibrous root near the surface, rather than any considerable development in the lower layers. In our paper on 'Turnip Culture,'* it was shown how much this distribution of surface root-fibres was increased by the use of superphosphate of lime. The same is the case with barley. It is obvious, that with this multiplication and more thickly distributed net-work of root-fibres, the greater must be the resources of the plant, within its comparatively limited period and area of growth. Thus it is, that the increased supply of certain important constituents within a limited area, enables the plant to provide itself more freely and rapidly with others it may require.

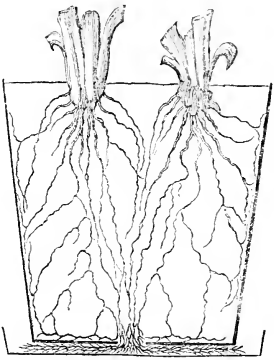
Whilst on this point it will not be out of place, in defect of

* Journal of Royal Agricultural Society, vol. viii., 1847.

the more pertinent illustrations, to quote some recent experiments, in which wheat and barley were respectively grown in pots, but with a very different object from that in reference to which they are here cited. In these experiments the distribution of the roots of the two plants was so strikingly different, that when disinterred rough sketches of them were made, of which the following are copies:—



BARLEY.



WHEAT.

The conditions under which these plants were grown, in pots, under cover, and both during the summer months, were, it is true, rather artificial. Still the contrast here shown is pretty characteristic of the plants as grown in our fields. These outlines will therefore serve to fix the mind on the bearing of the points we have been discussing. It may perhaps be further explained, that, whilst in the case of the barley plant only one single fibrile found its way through the bottom of the pot, the wheat threw out such a mass of ramifications that the whole of the surface of the dish in which the pot rested was covered with a thick network of roots; as also was the bottom, and to a great extent the sides, of the inside of the pot itself.

Still referring to the action and province of mineral manures applied to our crops grown on cultivated land, it has been shown on former occasions that, in a soil brought to what may be termed a condition of *agricultural* exhaustion—that is, at the end of a rotation, when in the ordinary course of things it would receive manure of some kind—the autumn-sown wheat was not increased in produce by the *direct* application of mineral manures, until so many crops had been taken from the land as to exhaust it of

mineral constituents more than would happen under nearly a century of ordinary rotation and home manuring. It has now been shown, that a very similar soil, certainly not more exhausted in an agricultural sense, gave an increase in the produce of *barley*, even on the first year's application of mineral manures. Collateral experiments in the same field, as well as those in other fields of very different, yet to a certain extent known history of relative exhaustion or fertility, showed however, that mineral manures were competent to yield, under these conditions of agricultural exhaustion, but a small amount of increase when compared with that obtained by nitrogenous manures. The evidence has also led to the conclusion, that the mineral manures, if at all, yielded increase in an extremely limited degree, unless there were available nitrogen accumulated by some means *within the soil;* in fact, that the increase of produce, other things being equal, was more in proportion to such available nitrogen within the soil, than to any other supplied condition. It has, however, recently been maintained in this Journal, that our characteristic nitrogenous manures cannot be said to be active in proportion to the nitrogen they contain.

Thus Baron Liebig states (Journal of the Royal Agricultural Society, vol. xvii. p. 298 *et seq.*) that ammonia alone, or nitric acid alone, has never been used in agricultural experiments; and he argues, that the acids in combination with ammonia in ammoniacal salts, and the bases in combination with nitric acid in the nitrates, will have had their share in the results obtained by the use of these salts; and that hence the value of such manures cannot depend upon the amount of their nitrogen, but must depend on the substances so combined with the nitrogen.

Before going on to Baron Liebig's further illustrations and arguments on the points here in question, it may be mentioned, in reference to the above statements of fact, that we have ourselves, as the reader is aware, used ammonia in combination with *carbonic acid* only, with very marked effects. The late Mr. Pusey, again, has given the account of his experiments in which nitric acid, soda, and potash, were each separately used upon grass. In reference to these experiments, Mr. Pusey says—" In both trials the nitric acid acted decidedly. The alkalies, neither of them, produced even a trace of effect on the colour or on the growth of the grass." And again—" The question being whether in saltpetre the alkalies or the acid contained the active principle, we have found upon a given soil the alkalies absolutely inoperative, while the acid has acted exactly like saltpetre itself and like ammonia."

It cannot for a moment be denied, that the state of combination of the nitrogen in our nitrogenous manures, or their admixture with other substances, has some share of influence on the result. We

have clearly shown that they have an influence, fluctuating according to season, exhaustion, amount employed, and other circumstances. It is, however, entirely inadmissible to attempt to draw any conclusions as to the influence of the state of combination of the nitrogen, or of the effect of substances supplied with it, from the comparison of the results of experiments in which unequal quantities of nitrogen are employed to a given area, or which were made indiscriminately in the same or in different seasons. Every one at all conversant with field experiments, will have been early impressed with the very varying proportional effect from one and the same manure, if used in different quantities in the same season, in even equal quantities in different seasons, and, above all, in unequal quantities in different seasons. But Baron Liebig founds his arguments upon the influence of the varying chemical combination of nitrogen, and upon the comparative effects of ammoniacal salts used *alone*, or in admixture with other constituents, upon experiments with nitrogen in these different states, made indiscriminately with different quantities of nitrogen to a given area, and in different seasons.

He compares together on this point—the increase by the use of sal-ammoniac *alone*, for one year, 1843, with that during three other years (1844, 1845, and 1846), by sal-ammoniac and phosphates applied in the first and third years only, and with that during the same three years (1844, 1845, and 1846) by guano applied only in the first (1844). The amounts of nitrogen supplied to a given area were also widely different. They were respectively 70·3 parts when the sal-ammoniac was used alone, 176 parts when it was used with phosphates, and only about 15 parts when the guano was employed. Nor is anything said of the varying seasons; to which his authority, Mr. Kuhlmann, calls particular attention. In this way, the increase being first calculated for a fixed amount of nitrogen in manure in each case, Baron Liebig arrives at the following varying result of the given amount of nitrogen as attributable to different states of combination, or to admixture with other manurial constituents:—

NITROGEN IN MANURE.	Yielded Increase of Produce.
100 parts in the form of Sal-ammoniac	2,439 parts of Hay.
,, ,, ,, Sal-ammoniac with phosphate of lime	4,367 ,, ,,
,, ,, ,, Guano	16,460 ,, ,,

No reader of this Journal will require to be told, that the results of about 70 parts of nitrogen to a given area in the form of sal-ammoniac alone in one year (1843)—of about 176 parts in the form of sal-ammoniac with phosphates applied partly in 1844

and partly in 1846, and the increase of produce taken over the three years (1844, 1845, and 1846)—and of about 15 parts of nitrogen in the form of guano applied only in 1844, and the increase taken over 1844, 1845, and 1846—are utterly incomparable with one another on the point here in question.

It should be mentioned with regard to the inferior result of a given amount of nitrogen as sal-ammoniac and phosphates, when compared with that in the form of guano, that Kuhlmann particularly stated that his crop by the former was in the first year (both hay and aftermath) so over-luxuriant from excess of manure, that it was necessarily cut before the proper time to prevent its rotting at the bottom.

With regard to the guano again, Kuhlmann states it to have contained 4·98 per cent. of nitrogen; but from the form of statement it does not seem clear whether this estimate was founded upon the analysis of the particular sample employed. As it is described as *Peruvian* guano, and also on account of the result, it is probable that the amount of nitrogen supplied in the guano was considerably greater than that assumed. After throwing out this observation, we, of course, take the results as apparently intended by M. Kuhlmann, and as quoted by Baron Liebig. But Kuhlmann gives two experiments, side by side, with the very same guano. The one supplied, according to his estimate, in round numbers, 15 parts of nitrogen to a given area, and the other 30 parts; but it is the result of the *smaller* amount only (15 parts), which Baron Liebig cites to compare with the 176 parts in the sal-ammoniac with phosphates. The comparison of the effects of a given amount of nitrogen in guano, used in the *single* and in the *double* quantity to a given area, is as follows:—

Nitrogen in M nure.	Yielded Increase of Produce.
100 parts in the form of Guano, when 300 * parts of it were employed	16,460 parts of Hay.
100 parts in the form of Guano, when 600 * parts of it were employed	9,566 „ „

Here then, a given amount of nitrogen in the form of combination and admixture of the very same guano, its action being taken over exactly the same seasons, gave 72 per cent. more increase when used in the smaller than in the larger quantity. Yet it is the action of the smaller quantity applied in one year, and acting over three, which Baron Liebig selects to contrast with the large amount of nitrogen applied in different seasons in

* For the convenience of round numbers we, with Baron Liebig, have assumed the guano to contain 5 per cent. of nitrogen instead of 4·98 per cent. as given by Kuhlmann.

the other manures, attributing the difference in result to the action of the associated mineral constituents.

After adducing (with some other) experimental evidence of this kind, Baron Liebig says :—

"By the use of the phosphate of lime, the effect of the ammonia in sal-ammoniac was almost doubled. By the action of the substances which in guano accompany the ammonia, the effect of the latter was made seven times greater than that of the same quantity in the shape of sal-ammoniac alone."

He also adds as a general conclusion, that—

"Since the effect of a manure is not proportional to the quantity of nitrogen it contains, it will be easily understood why the value of a manure cannot be estimated by its percentage of nitrogen."

It will be instructive to examine a little further Baron Liebig's reasoning upon experimental evidence. Further illustrating the action of the mineral constituents, he says :—

"Kuhlmann had manured a portion of his field in 1844 with a mixture of 666 lbs. of sal-ammoniac, along with phosphate of lime, and had obtained an excess of produce = 12,172 lbs. of hay per hectare. In the same year the portion manured with 500 lbs. of sulphate of ammonia (without phosphate of lime) yielded an excess = 3488 lbs. of hay. The former, therefore, yielded $2\frac{1}{2}$ times more excess of produce than the latter."

Here, be it observed, Baron Liebig compares the effect of 176 lbs.* of nitrogen *with phosphates*, with that of $101\frac{1}{2}$ lbs.* *without phosphates*, to illustrate the influence of these phosphates. He says :—

"By the addition of phosphate of lime to the ammoniacal salt the effect of the latter was augmented: there were obtained in all 8684 lbs. of hay more than by the use of ammoniacal salts alone. Now, in this excess, which is equal to $2\frac{1}{2}$ times the whole excess obtained by the ammoniacal salts alone, there were contained $2\frac{1}{2}$ times more silica, and $2\frac{1}{2}$ times more potash, than would have been removed from the soil *without the use of phosphate of lime along with the ammoniacal salts*;† and the soil was rendered necessarily by so much the poorer in these constituents."

Thus then, although there were $74\frac{1}{2}$ *lbs. more nitrogen supplied with the phosphates*, Baron Liebig attributes the 8684 lbs. of increase to the addition of the phosphates. But he continues :—

"This great loss of indispensable constituents could not be without influence on the subsequent crops. The field which in 1844 had been manured with 500 lbs. of sulphate of ammonia had no manure in 1845, and received, in 1846, 500 lbs. of the same ammoniacal salt. The result was as follows :— The same quantity of phosphate of lime and sal-ammoniac, which in 1844 had yielded a produce higher by 8684 lbs. than that of the field manured with sulphate of ammonia alone, yielded, in 1846, 3592 lbs. of hay. *The field manured with sulphate of ammonia alone yielded, in* 1846, 3726 *lbs. of hay; that is*, 124 *lbs.* (134) *more than the other.* The same manures which

* We here take the composition as given by Kuhlmann for the pure salts, as Baron Liebig has done the same. Kuhlmann states, however, that a deduction of 5 per cent. should be made for water and impurity.

† The italics are our own.

in 1844 had produced an enormous increase, and to which the unscientific and ignorant farmer would certainly, on account of this result, have attributed a preponderating value, lost, in 1846, their effect, although applied in the same quantity, and in the same proportions, to the same soil; and they lost their effect in the subsequent years, *in the same degree* * as they had at first produced a favourable result. The increased produce of the first year determined the diminished produce in the second and third years."

Here then, the deficiency of only 124 lbs. (134) of hay on the sal-ammoniac and phosphate plot in 1846, is attributed to its larger produce by 8684 lbs. in 1844. Further, this large increased produce in the first year, is said to determine the diminished produce in the "second," as well as in the third year. Baron Liebig does not quote the produce of the second year; but on reference to Kuhlmann's Paper, it is found that, instead of a "diminished" produce in the "second" year on the plot yielding the 8684 lbs. more increase than the sulphate of ammonia in 1844, that plot gives 240 lbs. *more* hay than the latter in the "second" year, 1845, when both were unmanured. Lastly, having omitted to quote the result of the second year, 1845, which was contrary to that stated, Baron Liebig speaks of the excess of 8684 lbs. of hay by the sal-ammoniac and phosphates in the first year, 1844, as the cause of the defect by the same manure of only 124 lbs. (134), in the third year. He treats these amounts as equal, thus—"they lost their effect in the subsequent years, *in the same degree* as they had at first produced a favourable result." Or, if the meaning were, that the sal-ammoniac and phosphates should, again in 1846, have given 8684 lbs. more increase than the sulphate of ammonia, and that, in this sense, the loss of effect was equal to the previous gain, this argument even, is quite inadmissible, as the comparative productive characters of the seasons are not taken into the calculation.

It is presumed that the best and only refutation needed, of the applicability of such evidence, and such reasoning, to establish the points in question, is to put them clearly before the reader.

How far it be really the case, that the inefficiency of the unrecovered supposed residue of nitrogen after the application of a nitrogenous manure, is due to the excessive exhaustion of mineral constituents, under the influence of the portion active and recovered—it requiring the peculiar action of additional salts of ammonia to set mineral constituents free and available—may perhaps be judged of by the results recorded in the foregoing pages, on the growth of barley after 10 years of turnips differently manured. During the growth of the 10 turnip crops, some of the plots had received every year enormously more of all the mineral constituents of the barley crop, except silica, than the turnips removed. The latter

* The italics here are our own; those in the earlier part of the paragraph are Baron Liebig's.

removed no silica. So that, besides the excess of other mineral constituents, there was an accumulation during 10 years of available silica. Yet with all this unusual accumulation of the necessary mineral constituents, the residue of nitrogen unrecovered in the increase of turnip crop—amounting as it did in some cases to more than the largest dressing we ever applied in one year to a corn crop—gave us, where there was the largest amount thus unrecovered, during 3 successive years of barley, an average annual increase of only $5\frac{3}{4}$ bushels of corn, and between 300 and 400 lbs. of straw, per acre. On the other hand, the addition of fresh nitrogen, in the form of salts of ammonia and nitrate of soda respectively, gave at once an increase of 33 and 35 bushels of corn, and 4903 and 5531 lbs. of straw. And although the addition of the fresh nitrogen in the form of ammoniacal salts yielded an increase of 33 bushels of corn and 4903 lbs. of straw, which together would contain only about half the nitrogen supplied in the manure, yet the remaining half, notwithstanding the still enormous excess of previously supplied mineral constituents, gave in the succeeding year only $6\frac{3}{4}$ bushels increase of corn and 646 lbs. of straw. Are we then to conclude, that, under the circumstances stated, the supposed large residue of nitrogen supplied to the turnips, was inefficient only for the want of available minerals?—and that the striking effects of the newly supplied lesser amounts of nitrogen were chiefly due to the action of the acids of the ammoniacal salts and of the soda of the nitrate, in rendering available the otherwise locked up mineral constituents within the soil? The utter inefficiency of even a liberal *direct* supply of mineral constituents, to recover, in the second crop of wheat after nitrogenous manures, more than an insignificant proportion of the supplied nitrogen not recovered in the first, has been forcibly illustrated in a former paper.

This brings us to a consideration of the experimentally ascertained proportion of nitrogen used in manure, which has been recovered in the increase of crop obtained. Before recording our own direct evidence on the point, as illustrated in the experiments with nitrogenous manures on barley which form the chief subject of this paper, it will be well to say a few words on some evidence and reasoning recently put forth on the subject by others, in this Journal.

In the article already alluded to (Jour. Roy. Ag. Soc., vol. XVII., Part I.), Baron Liebig adduces evidence and arguments to show, that, when the necessary mineral constituents are mixed with the nitrogen in manure, there is no *deficiency*, but a *gain* of nitrogen in the increase of crop. Assuming the increase of hay in Kuhlmann's experiments to contain 1 per cent. of nitrogen, Baron Liebig states that, where ammoniacal salts were used *alone*, there was an apparent loss of four-fifths or three-fourths of the

nitrogen employed. He then quotes an instance to prove that, where mineral constituents were also added, there was no such loss, but a gain from natural sources.

Below, we give the instance quoted by Baron Liebig as showing a *gain*, by the side of two other of Kuhlmann's experiments, which he does not quote on this point; but in both of which *mineral constituents were also employed.*

	Nitrogen in Increase for 100 in Manure.	Per cent. of Nitrogen in Increase more or less than in Manure.
1. Liebig's example of 15 parts of Nitrogen with Phosphates, in Guano, applied in one year, and acting over three years	164·60	+64·60
2. 30 parts of Nitrogen with Phosphates in the form of Guano, applied in one year, and acting over three years	95·66	−4·34
3. Sal-ammoniac containing 176 parts of Nitrogen with Phosphates, applied in the first and third years, and acting over the three years	43·67	−56·33

The result is then, that the only instance where there is an apparent gain was, where the practically speaking utterly insignificant amount of nitrogen in the form of guano, was used in one year, and the increase taken over that and the two succeeding years. Where Kuhlmann used only twice the amount of the very same guano, there was according to Baron Liebig's own method of calculation, a *loss* of more than 4, instead of a *gain* of 64 per cent. of the nitrogen employed. Lastly, where sal-ammoniac was used, in amount containing from 11 to 12 times as much nitrogen as the small quantity of guano, but *equally with it containing phosphates*, there was on the same mode of calculation, an apparent loss of 56·3 per cent., or more than half of the nitrogen employed. According to Baron Liebig's own data then, and his own mode of calculation, the farmer, to attain the happy result of no loss of the nitrogen of his manure, must employ it in quantity which is utterly insignificant in any practical point of view.

It will be seen that in the foregoing comments, we have not at all attempted on our own behalf, to discuss what is the real bearing of the evidence which Kuhlmann's experiments supply. Nor have we time or space to consider further the facts of others on the present occasion. It seemed desirable, however, before recording our own data and conclusions, to direct attention to the applicability of the facts selected, and the reasoning upon them, in reference to the points now in question, which have recently been submitted to the readers of this Journal on such high authority as that of Baron Liebig. Still less can we stop

here to do more than reiterate in a single sentence our assent to the palpable truism, that if the mineral constituents of our crops be deficient they must be supplied. We have on other occasions (to say nothing of the present paper), so fully illustrated the importance of keeping up a liberal provision in the soil of the mineral constituents of our crops—and also so frequently shown the usual circumstances of their removal or return, and the requirements for their direct supply, under an ordinary course of practical agriculture with rotation *as it is*—that we leave to the judgment of the reader, the pervading insinuation in the paper above referred to, that in our views the essentialness of the supply of the mineral constituents is ignored.

The experiments quoted by Baron Liebig to show the proportion of nitrogen recovered in the increase of crop to that supplied in manure, were made upon hay. We hope to record our results relating to that crop in an early paper. It will then be seen, how far facts relating to grass, when cut green, are applicable as the foundation of conclusions regarding a ripened cereal grain. On the present occasion we have only to show the proportion of nitrogen recovered to that supplied in manure, in the experiments on the growth of *barley*.

Were we to have attempted the direct determination of the nitrogen in every separate stock of the different nitrogenous manures used during the six years of the experiments in Hoos-Field, and also in the corn and straw produced each year on each of the 20 plots (making, as would be necessary, duplicate analyses in each case), this would have involved from 500 to 600 such determinations; a labour which we could not undertake. As it is, the number of nitrogen analyses recorded in the following Tables amounts to more than 100.

The percentages of nitrogen in pure sulphate and muriate of ammonia, and in nitrate of soda, are of course well known. As these substances occur in commerce, however, a certain average allowance has to be made for moisture and impurities. In estimating the amounts of nitrogen supplied to the soil by their use, we have made a deduction from the amounts they contain in a state of purity, founded not on the analysis of each sample actually employed, but on the experience of ourselves and others as to the average composition of the commercial salts. The exact amount of deduction thus made has been stated at page 488, and it is more probably too high than too low. On this supposition the amounts of nitrogen we have supplied in manure will be somewhat greater than has been assumed; and in this case, the numbers we arrive at to represent the proportion of the supplied nitrogen, which is recovered in the immediate increase, will be in a corresponding degree somewhat too high. The other nitrogenous manure employed, namely, rape-cake, will, according

to the estimate already given at pp. 488-9, most probably average below 5 per cent. of nitrogen. In the Table XVIII. the result is given both on the assumption of the above amount as a maximum, and of 4·1 per cent. as a minimum; rather above the mean between the two, would probably be very near the truth. It may be stated, however, that with the smaller percentage of nitrogen in the rape-cake, the 2000 lbs. of the manure employed per acre, would supply the same amount of nitrogen as the 400 lbs. of ammoniacal salts, and the 550 lbs. of nitrate of soda, used by its side.

In making the selection of the specimens of the *produce* to be analysed, the question arose—whether the results would bear a more general application if that of certain characteristic *individual* manures were taken?—or whether, omitting points of minor distinction, it would be better to endeavour to get the mean composition of the produce of *whole series* of plots, for each of the six years separately over which the experiments were continued? After consideration of the advantages and disadvantages of either partial course, the latter was adopted. The samples prepared for analysis were therefore as follows:—

1st. For each of the six years separately, a mixture of equal weights of the corn (and also the same of the straws), from each of the plots without nitrogenous manure. These comprised the unmanured plot, and those with respectively, the "Mixed Alkalies," the superphosphate of lime, and the mixed alkalies and superphosphate of lime together. The composition of these mixed samples, *grown without nitrogenous manure,* is taken to represent that of the produce yielded by the unaided soil and season resources of nitrogen in the several years.

2nd. For each year, a mixture of the produce (corn and straw separately), of each of the four plots where 200 lbs. of ammoniacal salts were employed per acre. That is, where this amount of ammoniacal salt was employed alone, or in addition to each of the three mineral manure conditions above referred to.

3rd. For each year, a mixture (corn and straw separately), from each of the four plots, with the otherwise unmanured or the same mineral manure conditions, where 400 lbs. of the ammoniacal salts per acre were used.

4th. For each year, a mixture (of corn and straw separately), from the produce where, in addition to the four above-mentioned standard non-nitrogenised conditions, 2000 lbs. per acre of rape-cake were employed.

5th. An equal mixture, for the five years together (corn and straw separately), of the produce during five consecutive years, by 275 lbs. of nitrate of soda per acre per annum.

6th. An equal mixture, also for the five years together (corn and straw separately), from the plots where double the amount, or 550 lbs. per acre per annum, of nitrate of soda were used.

These nitrogen determinations, which, counting the duplicates made on each specimen, amount to nearly 100, were all conducted in the Rothamsted laboratory, by Mr. John Masters; excepting that here and there repetitions have been made by Dr. Pugh or Mr. F. A. Manning for the purpose of confirmation. It may be added, that the process adopted was that by burning with soda lime, and estimating by the so-called "titrir" or volumetric method.

At the moment we are writing, the whole of the analyses which our plan should include are not completed, and we fear that the Tables will even eventually show some blanks. Notwithstanding these, we shall still have the means of illustrating incidentally, by a very extensive series of comparative results, the influence of season and manuring on the *percentage* of nitrogen in the barley crop. And, so far as the more special object of inquiry is concerned—namely, that of the relation of the nitrogen in the increase of produce to that in the manure employed—we shall be enabled to provide for six consecutive seasons, and for some of them for several different characteristic conditions of manuring, the important data of—

1st. The amount of nitrogen per acre in the corn, the straw, and the total produce.

2nd. The increase in the amount of nitrogen yielded per acre (in corn, in straw, and in total produce), by the use of given nitrogenous manures.

3rd. The proportions respectively, of the nitrogen *recovered*, and *not recovered*, in the increase, to a given amount (100 parts) supplied in manure.

The percentage and acreage results are given in Tables XVI., XVII., and XVIII. respectively, as follows:—

In Table XVI. the mean percentages of dry matter, and the actual determinations of nitrogen (and their mean) in the dry matter, of both the corn and straw, of the different mixed samples described above. By the side of these points of *composition*, are given some particulars of the *quantity and quality* of the produce analysed, for the study of the connection between them.

In Table XVII. similar particulars are given; excepting that here the percentages of nitrogen are calculated upon the corn and straw in their natural state of hydration. The percentages of nitrogen in this Table are therefore applicable to the produce as harvested.

Table XVIII. gives, besides the acreage amounts of the produce itself, the acreage amounts of nitrogen in the actual produce; the amounts in the actual increase; and finally, the proportions respectively, *recovered*, and *not recovered*, in the increase, for every 100 parts supplied in manure.

TABLE XVI.—SHOWING the MEAN PERCENTAGES of DRY MATTER, and the ACTUAL and MEAN of DETERMINATIONS of NITROGEN in the DRY MATTER, in BARLEY CORN, and STRAW, grown in different Seasons, and by different Manures, together with some particulars of the Quantity and Quality of the Produce analysed.

Years.	Particulars of Produce. Total Corn and Straw per Acre, lbs.	Per Cent. Corn in Total Produce.	Per Cent. Dressed Corn in Total Corn.	Weight per Bushel of Dressed Corn.	Composition of Corn. Per Cent. Dry Matter.	Per Cent. Nitrogen in Dry. Experiment 1.	Experiment 2.	Mean.	Composition of Straw. Per Cent. Dry Matter.	Per Cent. Nitrogen in Dry. Experiment 1.	Experiment 2.	Mean.
Series 1.—Without Nitrogen in Manure (Means of Unmanured, and Plots 4, 5, and 6).												
1852	3534	46·1	91·5	52·3	78·62	1·66	1·65	1·65	84·32	0·43	0·46	0·44
1853	3754	46·7	91·4	51·8	79·97	1·53	1·62	1·57	88·33	0·53	0·51	0·52
1854	4640	46·5	95·5	53·7	81·56	1·42	1·41	1·41	82·24	0·37	0·37	0·37
1855	3950	50·1	95·6	52·7	81·45	1·47	1·47	1·47	83·39	0·38	0·40	0·39
1856	1957	47·7	89·0	47·9	81·87	1·74	1·72	1·73	84·00	0·52	0·54	0·53
1857	3619	51·8	95·8	52·3	83·08	1·57	1·57	1·57	82·03	0·47	0·49	0·48
Mean	3576	48·1	93·1	51·9	81·09			1·57	84·05			0·46
Series 2.—With Ammoniacal Salts, giving per Acre about 41 lbs. Nitrogen (Means of Plots 8, 9, 10, and 11).												
1852	4999	43·8	88·5	50·9	79·32	1·78	1·81	1·79	84·44	0·47	0·48	0·47
1853	5129	44·9	88·0	52·6	79·74	1·70	1·75	1·72	87·91	0·49	0·51	0·50
1854	7200	43·5	94·5	54·0	81·59	1·48	1·48	1·48	82·17	0·44	0·40	0·42
1855	5697	44·9	93·7	51·8	80·48	1·74	1·69	1·71	83·38	0·51	0·52	0·51
1856	3694	41·0	89·6	47·6	81·29	1·72	1·71	1·71	84·17	0·48	0·49	0·48
1857	5329	50·7	96·7	53·3	83·04	1·83	1·79	1·81	83·35	0·55	0·54	0·54
Mean	5341	44·8	91·8	51·7	80·91			1·71	84·24			0·49
Series 3.—With Ammoniacal Salts, giving per Acre about 82 lbs. Nitrogen (Means of Plots 13, 15, 16, and 17).												
1852	5561	44·6	88·1	49·9	80·12	2·00	..	..	84·31	0·67		
1853	5620	43·5	88·9	51·4	79·83	2·02	..	..	86·87	0·59		
1854	8127	41·7	91·6	52·6	82·02	1·84	..	..	82·01	0·61		
1855	6678	39·4	92·9	49·9	80·14	2·07	2·08	2·07	82·75	0·71	0·71	0·71
1856	5008	35·6	85·8	46·8	82·29	1·99	2·00	1·99	83·90	0·63	0·62	0·62
1857	6524	49·1	95·6	52·8	82·93	2·18	2·10	2·14	83·90	0·65	0·64	0·64
Mean	6253	42·3	90·5	50·6	81·22			2·03	83·96			0·65
Series 4.—With Rape-Cake, giving per Acre 82-100 lbs. Nitrogen (Means of Plots 14, 18, 19, and 20).												
1852	4702	43·9	91·9	51·5	80·45	..	..	..	84·68			
1853	5190	43·2	86·4	51·2	79·26	..	..	..	87·55			
1854	8150	41·3	93·4	52·7	82·08	..	..	..	82·86			
1855	6823	40·2	92·5	50·1	81·73	2·09	2·08	2·08	83·96	0·68	0·71	0·69
1856	5039	36·4	90·1	46·6	82·56	1·94	1·94	1·94	84·49	0·63	0·64	0·63
1857	7161	48·9	95·5	53·8	82·84	1·92	1·91	1·91	83·79	0·47	0·48	0·47
Mean	6177	42·3	91·6	52·0	81·49			1·98	84·55			0·60
With Nitrate of Soda, giving per Acre about 41 lbs. Nitrogen (Plot 7).												
1853–7	5226	45·2	92·7	51·9	81·63	1·70	1·70	1·70	84·47	0·46	0·45	0·45
With Nitrate of Soda, giving per Acre about 82 lbs. Nitrogen (Plot 12).												
1853–7	6198	43·0	91·9	50·9	81·71	2·01	2·00	2·00	84·87	0·64	0·58	0·61

TABLE XVII.—SHOWING the MEAN PERCENTAGES of DRY MATTER, and the PERCENTAGE of NITROGEN, in BARLEY CORN, and STRAW, grown in different Seasons and by different Manures; CALCULATED on their CONDITION of DRYNESS as HARVESTED; together with some particulars of the Quantity and Quality of the Produce analysed.

YEARS.	PARTICULARS OF THE PRODUCE. Total Corn and Straw per Acre, lbs.	Per Cent. Corn in Total Produce.	Per Cent. Dressed Corn in Total Corn.	Weight per Bushel of Dressed Corn.	COMPOSITION OF CORN. Per Cent. Dry Matter.	Per Cent. Nitrogen in Fresh. Experiment 1.	Experiment 2.	Mean.	COMPOSITION OF STRAW. Per Cent. Dry Matter.	Per Cent. Nitrogen in Fresh. Experiment 1.	Experiment 2.	Mean.
SERIES 1.—Without Nitrogen in Manure (Means of Unmanured, and Plots 4, 5, and 6).												
1852	3534	46·1	91·5	52·3	78·62	1·30	1·30	1·30	84·32	0·36	0·39	0·37
1853	3754	46·7	91·4	51·8	79·97	1·22	1·30	1·26	88·33	0·47	0·45	0·46
1854	4640	46·5	95·5	53·7	81·56	1·16	1·15	1·15	82·24	0·30	0·30	0·30
1855	3950	50·1	95·6	52·7	81·45	1·20	1·20	1·20	83·39	0·32	0·33	0·32
1856	1957	47·7	89·0	47·9	81·87	1·42	1·41	1·41	84·00	0·44	0·45	0·44
1857	3619	51·8	95·8	52·8	83·08	1·30	1·30	1·30	82·03	0·38	0·40	0·39
Mean	3576	48·1	93·1	51·9	81·09			1·27	84·05			0·38
SERIES 2.—With Ammoniacal Salts, giving per Acre about 41 lbs. Nitrogen (Means of Plots 8, 9, 10, and 11).												
1852	4999	43·8	88·5	50·9	79·32	1·41	1·44	1·42	84·44	0·40	0·40	0·40
1853	5129	44·9	88·0	52·6	79·74	1·36	1·39	1·37	87·91	0·43	0·45	0·44
1854	7200	43·5	94·5	54·0	81·59	1·21	1·21	1·21	82·17	0·36	0·33	0·34
1855	5697	44·9	93·7	51·8	80·48	1·40	1·36	1·38	83·38	0·42	0·43	0·42
1856	3694	41·0	89·6	47·6	81·29	1·40	1·39	1·39	84·17	0·40	0·41	0·40
1857	5329	50·7	96·7	53·3	83·04	1·52	1·49	1·50	83·35	0·46	0·45	0·45
Mean	5341	44·8	91·8	51·7	80·91			1·38	84·24			0·41
SERIES 3.—With Ammoniacal Salts, giving per Acre about 82 lbs. Nitrogen (Means of Plots 13, 15, 16, and 17).												
1852	5561	44·6	88·1	49·9	80·12	1·60			84·31	0·56		
1853	5620	43·5	88·9	51·4	79·83	1·61			86·87	0·51		
1854	8127	41·7	91·6	52·6	82·02	1·51			82·01	0·50		
1855	6678	39·4	92·9	49·9	80·14	1·66	1·67	1·66	82·75	0·59	0·59	0·59
1856	5007	35·6	85·8	46·8	82·29	1·64	1·65	1·64	83·90	0·53	0·52	0·52
1857	6524	49·1	95·6	52·8	82·93	1·81	1·74	1·77	83·90	0·55	0·54	0·54
Mean	6253	42·3	90·5	50·6	81·22			1·65	83·96			0·54
SERIES 4.—With Rape-Cake, giving per Acre 82-100 lbs. Nitrogen (Means of Plots 14, 18, 19, and 20).												
1852	4702	43·9	91·9	51·5	80·45				84·68			
1853	5190	43·2	86·4	51·2	79·26				87·55			
1854	8150	41·3	93·4	52·7	82·08				82·86			
1855	6823	40·2	92·5	50·1	81·73	1·71	1·70	1·70	83·96	0·57	0·60	0·58
1856	5039	36·4	90·1	46·6	82·56	1·60	1·60	1·60	84·49	0·53	0·54	0·53
1857	7161	48·9	95·5	53·8	82·84	1·59	1·58	1·58	83·79	0·39	0·40	0·39
Mean	6177	42·3	91·6	52·0	81·49			1·63	84·55			0·50
With Nitrate of Soda, giving per Acre about 41 lbs. Nitrogen (Plot 7).												
1853-7	5226	45·2	92·7	51·9	81·63	1·39	1·39	1·39	84·47	0·39	0·38	0·38
With Nitrate of Soda, giving per Acre about 82 lbs. Nitrogen (Plot 12).												
1853-7	6198	43·0	91·9	50·9	81·71	1·64	1·63	1·63	84·87	0·54	0·49	0·52

TABLE XVIII.—SHOWING, in Lbs., the FRESH PRODUCE per ACRE, the NITROGEN per ACRE in PRODUCE, the NITROGEN per ACRE in INCREASE by NITROGENOUS MANURE, and the NITROGEN RECOVERED, or NOT RECOVERED, in INCREASE, for 100 supplied in MANURE.

YEARS.	Mean Produce per Acre, lbs.			Nitrogen per Acre, in Mean Produce, lbs.			Nitrogen per Acre, in Mean Increase, lbs.			For 100 Nitrogen in Manure. Nitrogen Recovered in Increase.			Not Recovered in Increase.
	Corn.	Straw.	Total.	Corn.	Straw.	Total.	Corn.	Straw.	Total.	Corn.	Straw.	Total.	
SERIES 1.—Without Nitrogen in Manure (Mean of Unmanured and Plots 4, 5, and 6).													
1852	1628	1906	3534	21·16	7·05	28·21							
1853	1754	2000	3754	22·10	9·20	31·30							
1854	2159	2481	4640	24·83	7·44	32·27							
1855	1978	1972	3950	23·74	6·31	30·05							
1856	933	1024	1957	13·15	4·51	17·66							
1857	1875	1744	3619	24·37	6·80	31·17							
Mean	1721	1855	3576	21·56	6·88	28·44							
SERIES 2.—With Ammoniacal Salts, giving per Acre about 41 lbs. Nitrogen (Means of Plots 8, 9, 10, and 11).													
1852	2190	2809	4999	31·10	11·24	42·34	9·94	4·19	14·13	24·2	10·2	34·4	65·6
1853	2301	2828	5129	31·52	12·44	43·96	9·42	3·24	12·66	23·0	7·9	30·9	68·1
1854	3131	4069	7200	37·88	13·83	51·71	13·05	6·39	19·44	31·8	15·6	47·4	52·6
1855	2561	3136	5697	35·34	13·17	48·51	11·60	6·86	18·46	28·3	16·7	45·0	55·0
1856	1519	2175	3694	21·11	8·70	29·81	7·96	4·19	12·15	19·4	10·2	29·6	70·4
1857	2703	2626	5329	40·54	11·82	52·36	16·17	5·02	21·19	39·4	12·2	51·6	48·4
Mean	2401	2940	5341	32·91	11·87	44·78	11·36	4·98	16·34	27·7	12·1	39·8	60·2
SERIES 3.—With Ammoniacal Salts, giving per Acre about 82 lbs. Nitrogen (Means of Plots 13, 15, 16, and 17).													
1852	2483	3078	5561	39·73	17·24	56·97	18·57	10·19	28·76	22·6	12·4	35·0	65·0
1853	2445	3175	5620	39·36	16·19	55·55	17·26	6·99	24·25	21·0	8·5	29·5	70·5
1854	3393	4734	8127	51·23	23·67	74·90	26·40	16·23	42·63	32·2	19·8	52·0	48·0
1855	2629	4049	6678	43·64	23·89	67·53	19·90	17·58	37·48	24·3	21·4	45·7	54·3
1856	1781	3227	5008	29·21	16·78	45·99	16·06	12·27	28·33	19·6	14·9	34·5	65·5
1857	3202	3322	6524	56·67	17·94	74·61	32·30	11·14	43·44	39·4	13·6	53·0	47·0
Mean	2655	3598	6253	43·31	19·28	62·59	21·75	12·40	34·15	26·5	15·1	41·6	58·4
SERIES 4.—With Rape-Cake, giving per Acre 82–100 lbs. Nitrogen (Means of Plots 14, 18, 19, and 20).													
1852	2064	2638	4702										
1853	2244	2946	5190										
1854	3367	4783	8150										
1855	2742	4081	6823	46·61	23·67	70·28	22·87	17·36	40·23	27·9	21·2	49·1	50·9
1856	1834	3205	5039	29·34	16·99	46·33	16·19	12·48	28·67	19·7	15·2	34·9	65·1
1857	3505	3656	7161	55·38	14·26	69·64	31·01	7·46	38·47	37·8	9·1	46·9	53·1
Mean	2626	3551	6177	43·78	18·30	62·08	23·36	12·43	35·79	28·4	15·2	43·6	56·4
With Nitrate of Soda, giving per Acre about 41 lbs. Nitrogen (Plot 7).													
1853-7	2364	2862	5226	32·86	10·88	43·74	11·22	4·03	15·25	27·4	9·8	37·2	62·8
With Nitrate of Soda, giving per Acre about 82 lbs. Nitrogen (Plot 12).													
1853-7	2666	3532	6198	43·46	18·37	61·83	21·82	11·52	33·34	26·6	14·0	40·6	59·4

From the extent to which our paper has already reached, as well as from the incompleteness of our Tables at the moment we are obliged to conclude for the press, we must forego the adequate consideration of the mass of important data they will provide, and content ourselves with giving some direction to the more careful study of the reader.

A few words should first be said, on the influence of season and manuring, upon the *percentage* of nitrogen in the produce of barley. And whilst on this point, we may refer the reader to a rather fuller, though still only summary, treatment of the effects of these agencies on the nitrogenous percentage of *wheat*, given in the 'Quarterly Journal of the Chemical Society,' vol. x., part i., April 1857. In the main, their direction and tendency are very similar with the two crops, though differing incidentally on certain points.

Referring to the influence of varying *season*, we find both the grain and straw, when grown without nitrogenous manure, to show a tendency to relatively low percentage of nitrogen, the higher the characters of the produce as indicated by general coincidence of high proportion and weight per bushel of corn, with comparatively full amount of crop per acre. It will be remembered that 1854, 1855, and 1857, were the best corn-yielding years, whilst 1856 was the worst. Accordingly, 1854 and 1855 show the lowest percentage of nitrogen in the corn, and also in the straw; 1856, on the other hand, gives the highest percentage in the corn, and about the highest in straw. On the average of the few seasons before us then, so far as the crops grown without nitrogenous manure are concerned—that is, those which ripened best—the tendency was to give the lower percentage of nitrogen, the higher the character of the crop, and *vice versâ*. The same was the case with wheat. But as with it, so with barley, the rule is not without exception, but would seem only to apply on the average, as our seasons go. The most striking exception in the Table before us is 1857; when, with an unusually favourable season for yield and maturation of corn, we had, compared with the other good years, a somewhat high percentage of nitrogen in both corn and straw.

Turning to the produce grown by nitrogenous manures, and again comparing season with season, the rule just indicated does not seem to be so clearly borne out. When, however, it is considered that the influence of the nitrogenous manures, even when used in the smaller of our adopted quantities, was to produce over-luxuriance, and to depreciate the proportion and quality of the grain—that is, to be unfavourable to the most perfect maturation—it will be seen, that an apparent exception under these circumstances, is rather a confirmation of the assumption that

high maturation and low percentage of nitrogen are generally, with the average of our seasons, coincident.

In further illustration of the adverse influence of too high manuring on the proportion and quality of the corn, and of the fact that the tendency of depreciation in the latter is to give a higher percentage of nitrogen, we may refer to the *mean lines* in Tables XVI. or XVII. It will there be seen that, on the average of the six years, all the enumerated characters of quality of produce, were lower where even the smaller quantity of ammoniacal salts was used, than where none at all were employed; and they were lower still with the larger amounts of them. And, again, where the rape-cake was used, the average qualities were intermediate between those by the larger and the smaller amounts of ammoniacal salts. The mean percentages of nitrogen, so far as the Tables provide them, are, on the view which has been assumed, entirely consistent with these indications. Thus, in both corn and straw, the mean percentage of nitrogen was lowest where no nitrogenous manure was employed—that is, where the average characters of quality of the produce were the highest. It was higher with the small amount of ammoniacal salts, and higher still with the larger amount; and with the rape-cake it was intermediate between the two. The same is borne out on comparing the characters and composition of the produce by the smaller, with those by the larger amount of nitrate of soda. With the smaller amount of nitrate, we have, taking an average of the five seasons, the higher proportion of corn, the larger proportion of dressed corn in total corn, and the higher weight per bushel of dressed corn, and, with these higher qualities of produce, the lower percentage of nitrogen in both corn and straw.

That we should get the higher *qualities* of crop indicated with the lowest amounts of produce per acre, is perfectly consistent with the practically admitted fact, that the *sample*, particularly of barley, is, on the average, the better the smaller the amount of crop. This smaller amount of crop, is coincident with the relative deficiency of available nitrogen within the soil. And, with this higher quality of sample obtained with a low relative provision of nitrogen in the soil, we have a tendency to low percentage of nitrogen in the most valuable descriptions of the grain. But *quality*, cannot in practice be bought at so great a sacrifice of *quantity*. And it is seen that, when we increase the *quantity of crop* by increasing the relative amount of available nitrogen in the soil, it is generally depreciated in the admitted characters of *quality*; and at the same time the percentage of nitrogen is increased. Further, the tendency to diminished quality and increased percentage of nitrogen on the one hand, with increased amount of crop on the other, would appear to be the greater, the more excessive the

supply of nitrogen beyond that which in the average of seasons can yield a well-conditioned and healthily ripened crop. Barley indeed, from its comparatively limited hold on the soil, and its small and weakly straw in proportion to the weight of corn it has to carry, is, so far as favourable ripening and good sample are concerned, more sensitive to vicissitudes of season and to high manuring than wheat. And it is with the greater variation in degree of maturation in the former than in the latter, in one and the same season with different proportions of available nitrogen provided within the soil, that we have at the same time, a greater variation in the *percentage* of nitrogen in the produce depending on the manure employed.

Upon the whole it may be considered that, the percentages of nitrogen in our produce of barley grown without nitrogenous manure, were, for the soil and season in question, lower than they would be in the ordinary practice of farming, owing to a constant relative defect of nitrogenous supply for that amount of crop, which the soil and seasons were otherwise competent to bring to a practically sufficient degree of perfection. On the other hand, the figures in the Tables, taken together with the circumstances of growth and the characters of the produce to which they refer, would lead to the belief that, on the average of seasons, the percentage of nitrogen can be but little increased beyond the perhaps abnormally low amount obtained where the nitrogenous supply was obviously in defect, without at the same time a diminution in the practically admitted characters of high quality of the corn. In fact, it would appear probable, that we cannot, keeping within the limit of healthily matured full crops, increase the percentage of nitrogen in our barley grain much above a comparatively low amount, as our seasons go. Yet, the fact that in 1857, which was an unusually favourable season for the proportion and the ripening of the corn, we had a high percentage of nitrogen in the dry substance of that corn, supplies us for barley (as was found in the case of wheat*), with an interesting exception to any too wide an application of that which may nevertheless be taken as a general tendency, at least within the limits of our own locality and average climatic conditions.

It is owing to the great influence of vicissitudes of season upon the *condition* of the crop when harvested, that the percentages of dry matter in the produce, and especially of the straw, of our experimentally grown barley, have not the obvious connection with the other points of composition of the crop that we should otherwise have expected. Adequately to discuss these variations in the percentage of dry matter, due to season and manuring,

* See Quarterly Journal of the Chemical Society, before referred to.

would require the record and coincident study of the *percentages of ash* in that dry matter—of which unfortunately our series of determinations are at present too incomplete.

We pass on, therefore, after these few observations on the effects of season and manuring upon the *percentage* of nitrogen in the barley crop, to the application of the analytical results to determine the proportion of nitrogen recovered in the increase of crop, for a given amount supplied in manure. Table XVIII. supplies us with our data on this point.

A preliminary point of interest in this Table is, the information it affords of the amount of nitrogen annually taken from the land in the produce, where none was supplied in manure. The highest amount of nitrogen thus stored up from the unaided soil and season resources was in 1854, namely, 32¼ lbs. per acre; the lowest amount was 17½ lbs. in 1856; and the average annual yield, taking the mean of the 6 years, was about 28⅓ lbs. It may be mentioned, that this latter amount, is more than that annually deposited in rain and other aqueous depositions, in the forms of ammonia and nitric acid. Investigation, of which there is at the present time much going on in reference to this subject, has still to determine the source or sources of this annual excess of assimilated nitrogen, beyond that supplied in the combined form in the measured and analysed aqueous depositions. Whether it be due to exhaustion of previously accumulated nitrogen in the soil—to direct condensation by the latter of the nitrogenous compounds occurring in the atmosphere—to the formation of ammonia or nitric acid within the soil at the moment of the evolution by chemical changes of certain elements in the nascent state—to the accumulation of combined nitrogen from the atmosphere by the plant itself—or to its assimilation of the free nitrogen of the atmosphere—whether, or in what proportion, these several possible sources may take part in the result, is as yet a great problem open for solution?

For the convenience of round numbers, and to be sure of making full allowance for impurity in the manures employed, we have, as already stated more than once, assumed that the 200 lbs. of ammoniacal salts per acre (100 lbs. each sulphate and muriate), and the 275 lbs. nitrate of soda, respectively supplied 41 lbs. of nitrogen, equal 50 lbs. of ammonia, per acre. The double amounts, namely, the 400 lbs. of mixed ammoniacal salts, and the 550 lbs. nitrate of soda, of course each supplied, on the same calculation, 82 lbs. of nitrogen per acre, equal 100 lbs. of ammonia. The 2000 lbs. of rape-cake, on the lowest estimate, would supply 82 lbs. also, but more probably nearer 100 lbs. nitrogen per acre. Taking, as we have done, low rather than high estimates of the nitrogen supplied in the various manures, it is obvious that the

amount represented in the Tables as *unrecovered* in the increase of crop, will be under rather than over stated.

It has been seen that the average annual produce of nitrogen in the barley crop was, without nitrogenous manure, from $17\frac{1}{2}$ to $32\frac{1}{4}$ lbs. per acre per annum, giving an average of about $28\frac{1}{3}$ lbs. The Table further shows that, when at least 41 lbs. of nitrogen were annually added per acre, in the forms respectively of ammoniacal salts and nitrate of soda, we obtained an average annual increase of nitrogen in the crop of about $16\frac{1}{3}$ lbs. when the ammoniacal salts were used, and about $15\frac{1}{4}$ lbs. when the nitrate of soda was used. Again, when double the amount, or at least 82 lbs. of nitrogen per acre, per annum, were added, we recovered when it was given in the form of ammoniacal salts about $34\frac{1}{4}$ lbs., and when as nitrate of soda, about $33\frac{1}{3}$ lbs., in the increase of crop. Lastly, by from 82 to 100 lbs. of nitrogen annually supplied in the form of rape-cake, we got back, taking the average of three years only, not quite 36 lbs. in increase.

If, instead of stating the actual *acreage* amounts as above, we represent the *proportion* of nitrogen recovered or unrecovered in the increase, *for* 100 *parts supplied in manure*, the result is as follows. Where about 41 lbs. of nitrogen were added per acre, per annum, in the form of ammoniacal salts, we get back in the increase, on the average of six years, $39\frac{3}{4}$ per cent. of the amount supplied; there are unrecovered therefore, about $60\frac{1}{4}$ per cent. of the so supplied nitrogen. When about the same amount of nitrogen was supplied in the form of nitrate of soda, the average of five years shows $37\frac{1}{4}$ per cent. recovered, and $62\frac{3}{4}$ per cent. not recovered, in the increase. It will be remembered, that it was in these instances where there is seen to be an average of 60 per cent., or rather more, of the supplied nitrogen unrecovered in the increase, that we had a far better yield of increased produce of corn and straw for a given amount of nitrogen supplied in manure, than where the larger amounts of the latter were employed. It is worthy of remark, that, notwithstanding the far higher proportion of increase of corn and straw for a given amount of nitrogen in manure, where the smaller quantity was employed, we have, where the larger amount was used, also the larger *proportion* of it recovered in the increase. Thus, instead of 39·8 per cent. recovered, and 60·2 per cent. unrecovered, as with the smaller amounts of nitrogen in manure, we have with the 82 lbs. of nitrogen per acre in ammoniacal salts, rather more, or 41·6 per cent. recovered. Again, the larger amount of nitrogen given as *nitrate of soda*, taking the average of five years, afforded 40·6 per cent. recovered in increase, by the side of only 37·2 per cent. when half the amount of the nitrate was employed. Lastly, taking the rape-cake to have supplied its minimum amount of

nitrogen—that is, the same as the larger amounts of ammoniacal salts and nitrate of soda—it will then have returned rather the largest proportion of any, namely, 43·6 per cent. Assuming, however, that the 2000 lbs. of rape-cake supplied its maximum amount, or 100 lbs. of nitrogen per acre, then the return would be only 35·8 per cent. of the supplied nitrogen. The probability is, that the average amount supplied was very nearly the mean between the two; and, in that case, the proportion of nitrogen returned in increase, for that supplied by rape-cake, will agree very closely with that obtained when the ammoniacal salts and the larger amount of nitrate of soda were employed.*

The fact is, then, that in each case the average percentage of the supplied nitrogen, which was recovered in the increase, was rather greater where the excessive amounts of nitrogen were supplied in manure, which gave over-luxuriant and damaged crops, and a less amount of increased produce for nitrogen supplied. This result, of the larger proportion of supplied nitrogen recovered, where the amounts in manure were excessive, is obviously due to the much higher *percentage* of nitrogen in the produce, under these circumstances. It has been seen, that an increased percentage of nitrogen by the use of it in manure is, if beyond a comparatively narrow limit, most probably accompanied with a depreciation in those qualities which in practice give high rate of value to the corn. This applies more particularly where the demand is chiefly for malting purposes. Upon the whole then, the slightly larger proportional return of nitrogen in increase for nitrogen supplied in manure, where the larger amounts of the latter were employed, is but a very questionable advantage.

The general result is seen to be that, in the experiments in question, when the nitrogen supplied in manure was not excessive, scarcely 40 per cent. of it was recovered in the increased produce of corn and straw obtained, taking the average of several successive years. In some of the individual years there were less than 30 per cent. of the supplied nitrogen recovered, and in others —that is, where the tendency to corn was the highest—there were nearer, or even over 50 per cent. recovered.

In thus speaking of the proportion of the supplied nitrogen recovered in the immediate increase of the barley crop, our form of statement must be understood as only representing the practical result, as measured by the difference between the amount of nitrogen in the produce with nitrogenous manures, and in that without them. It must be admitted, that we have not the means of

* It should be mentioned that the above results relating to the large amounts of ammoniacal salts are founded, for three years out of the six, upon single determinations of nitrogen in the produce, instead of duplicates; and those relating to the rape-cake apply to only three years instead of six.

deciding whether or not the crop grown by nitrogenous manure, has assimilated the same amount of nitrogen from other sources as that grown without it. We cannot say, therefore, whether the soil has to render an account of more or less of nitrogen than that indicated by the column of the amounts unrecovered in the increase of crop. The proportion unrecovered in the immediate increase is, however, obviously very large. It may be supposed that this at first unrecovered amount, is still available to after-crops? We may as alternatives assume—that a portion is locked up in the soil in a practically unavailable form?—that it passes into states of combination in which it can be drained away, or evaporated, from the soil?—or lastly, that in some form or other it is got rid of by the functional processes of the growing crop? The actual or relative amounts of these several influences, science is not yet able to determine.

It is obvious that, at any rate some of the apparent loss to immediate increase, of the supplied nitrogen, will be due to the unequal distribution of the manure in relation to the underground feeders of the plant. If this were all, however, the unrecovered nitrogen in a first crop, should be sooner or later available to those which follow. But one thing is certain; that, even taking together the increase in several immediately succeeding after years, the *proportion* then recovered of the previously unrecovered nitrogen, is very much less than the *proportion* of the whole supplied, which is recovered in the year or years of its application. This is even the case when the provision of the necessary mineral constituents is very liberal. Indeed, a much less amount of nitrogen newly supplied in the form of salts of ammonia or nitrate of soda alone, will give a greater increase of produce than the larger amount of supposed residual nitrogen, with direct mineral manures in addition. It cannot well be supposed, therefore, that the amount of the supplied nitrogen unrecovered, is simply due to its greater distribution, though still remaining, so far as state of combination is concerned, *available.*

As a fact in practical agriculture, it must be concluded, that the nitrogen supplied in manure for full crops of grain, is not recovered in the increase within any moderate period of time. We hope on an early occasion to add to the statistical results in this and in former Papers on other crops, those relating to the proportion of nitrogen recovered in increase, to that supplied in manure, for *grass.* But even with all the evidence which the facts of the field will be able to provide, the exact explanation of the loss which is experienced by practice will still remain to be given by science.

END OF VOL. XVIII.

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Royal Agricultural Society of England.

1857—1858.

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MEMORANDA.

ADDRESS OF LETTERS.—The Society's office being situated in the new postal district designated by the letter W, members, in their correspondence with the Secretary, are requested to subjoin that letter to the usual address.

GENERAL MEETING in London, in December, 1857.

GENERAL MEETING in London, on Saturday, May 22, 1858, at Twelve o'clock.

COUNTRY MEETING at Chester in 1858.

MONTHLY COUNCIL (for transaction of business), at 12 o'clock on the first Wednesday in every month, excepting January, September, and October: open only to Members of Council and Governors of the Society.

WEEKLY COUNCIL (for practical communications), at 12 o'clock on all Wednesdays in February, March, April, May, June, and July, excepting the first Wednesday in each of those months, and during adjournment: open to all Members of the Society, who are particularly invited by the Council to avail themselves of this privilege.

ADJOURNMENTS.—The Council adjourn over Easter week, and occasionally over Passion and Whitsun weeks; from the first Wednesday in August to that in November; and from the first Wednesday in December to the first Wednesday in February.

GUANO analysed for Members at a reduced rate by Professor WAY, at 15, Welbeck Street, Cavendish Square, London.—(Statement of Members' Privileges of Chemical Analysis given in Journal, vol. XVII., Appendix, pp. xiii, xlvi, vol. XVIII., Appendix, p. xlii, and may be obtained separately on application to the Secretary.)

DISEASES of Cattle, Sheep, and Pigs.—Members have the privilege of applying to the Veterinary Committee of the Society; and of sending animals to the Royal Veterinary College, on the same terms as if they were subscribers to the College.—(Statement of Members' Veterinary Privileges given in Journal, vol. XI., Appendix, pp. viii, ix; vol. XII., Appendix, p. iv; vol. XIII., Appendix, p. xxxiv; vol. XIV., Appendix, p. v; and may be had separately on application to the Secretary.)

LOCAL CHEQUES: requested not to be forwarded for payment in London; but London Cheques, or Post-office Orders (payable to "James Hudson"), to be sent in lieu of them. Members may conveniently transmit their Subscriptions to the Society, by requesting their Country Bankers to pay (through their London Agents) the amount at the Society's Office (No. 12, Hanover Square, London), between the hours of ten and four, when official receipts, signed by the Secretary, will be given for such payments.

NEW MEMBERS.—Every candidate for admission into the Society must be proposed by a Member; the proposer to specify in writing the full name, usual place of residence, and post-town, of the candidate, either at a Council meeting, or by letter addressed to the Secretary.

PACKETS BY POST.—Packets not exceeding two feet in length, width, or depth, consisting of written or printed matter (but not containing letters sealed or open), if sent without envelopes, or enclosed in envelopes open at each end, may be forwarded by the inland post, if stamped, at the following rates:—

For a packet not exceeding	4	ounces	(or quarter of a pound)	. . .	1	penny.
" " "	8	"	(or half a pound)	. . . .	2	pence.
" " "	16	"	(or one pound)	. . . . .	4	"
" " "	24	"	(or one pound and a half)	. .	6	"
" " "	32	"	(or two pounds)	. . . . .	8	"

[And so on in the proportion of 8 ounces for each additional 2*d*.]

*** Members may obtain on application to the Secretary copies of an Abstract of the Charter and Bye-Laws, of a Statement of the General Objects, &c., of the Society, and of other printed papers connected with special departments of the Society's business.

Royal Agricultural Society of England.

GENERAL MEETING,

12, Hanover Square, Friday, May 22, 1857.

REPORT OF THE COUNCIL.

The Society consists at the present time of—

83 Life Governors,
137 Annual Governors,
896 Life Members,
3933 Annual Members, and
19 Honorary Members,

making a total of 5068, or an increase of 89 names on the list of the Society since the last Anniversary Meeting.

During the past half-year the Society has lost by death two of its earliest members, the Duke of Rutland, a trustee, and Mr. Francis Woodward, one of the general Members of Council, each, within his respective sphere, distinguished for his devotion to agriculture, and for promoting the welfare of all connected with its pursuit. The Council have supplied the vacancies consequent on their decease, by the election of Mr. Bramston, M.P., as a Trustee, and of Mr. Pain, Mayor of Salisbury, and Mr. Paget, M.P., as general Members of the Council.

The invested capital of the Society stands at 9264*l.* 8*s.* 11*d.* stock in the New Three per Cents., and the current cash-balance in the hands of the Bankers on the 1st instant was 1087*l.*

The Consulting Chemist of the Society is engaged in investigations on the solubility of various substances in the soil which supply nourishment to plants. He has also delivered a lecture before the members on the general character and geographical distribution of guano deposits, and has made his annual report on the details connected with his department. The Council have

been favoured by Professor Henfrey, of King's College, with a lecture delivered before the members, on the nutrition of plants, elucidating the organization and functions by which they derive and assimilate the nutriment obtained by them from various sources.

The Council have again to record their sense of the interest taken by the Earl of Clarendon in promoting the objects of the Society, by obtaining from the Ministers and Consuls abroad not only information on the occurrence of guano and other manuring substances, but also details connected with the progress of pleuro-pneumonia and contagious typhus among the cattle in different parts of Europe. The Council having received from the Royal Agricultural Improvement Society of Ireland a suggestion that it would be desirable for the three national Agricultural Societies of the United Kingdom to join in despatching abroad a special Veterinary Inspector, for the purpose of ascertaining the exact nature of the contagious typhus, they at once concurred with the Highland and Agricultural Society of Scotland in adopting that suggestion; and on the 9th of last month Professor Simonds, furnished with a circular letter from the Earl of Clarendon to the several Consuls of Europe, left England as the Veterinary Inspector of the three National Societies, and on the 30th forwarded his first communication, in which he reports that he found, to a great extent, that the pleuro-pneumonia had been mistaken for the severer malady of contagious typhus; and that he had to penetrate into Poland itself in order to meet with cases that might furnish subjects for his study and report. He expresses his firm opinion that there is, at present, no fear of the contagious typhus being introduced into this country by means of living animals, whatever danger may arise from the importation of hides or other integumentary portions of slaughtered cattle.

The arrangements for the Salisbury Meeting, to be held in the third week of July, are proceeding satisfactorily. A very large entry is already made of implements; and the entries for stock, which close on the 1st of next month, promise to be equally numerous. The implements at work will this year be presented under a new arrangement, which will essentially tend to increase the interest of that part of the Show.

The Council have decided, subject to the usual conditions, to hold the Society's Country Meeting next year at Chester; and have determined that the district for the year 1860 shall consist of the counties of Kent and Surrey.'

While the Chelmsford Meeting of last year was highly successful in promoting the objects of the Society, it also proved in its results to have been one of the most expensive in a financial point of view; and the Council have under their consideration the adoption of various modifications which may tend to reduce the expenditure of future country meetings, without diminishing their practical efficiency.

The steady increase of permanent Members on the list of the Society, the great interest taken in its country meetings, and the gradual union of the owners and occupiers of land, who are thus brought into communication with each other, and led to co-operate in the common object of promoting their individual interests, while advancing at the same time the general cultivation of the country and the principles of rational agriculture throughout the world, are circumstances which afford well-grounded satisfaction at the beneficial influence of the Society's past operations, and a just expectation of its continued and increasing usefulness.

By order of the Council,

JAMES HUDSON, Secretary.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

Half-Yearly Account from the 1st of July to the 31st of December, 1856.

Receipts during the half-year.

	£.	s.	d.
Balance in the hands of the Bankers, July 1, 1856	3299	12	2
Petty Cash Balance in the hands of the Secretary, July 1, 1856	22	15	5
Dividends on Stock	129	14	1
Governors' Annual Subscriptions	15	0	0
Members' Life-Compositions	230	0	0
Members' Annual Subscriptions	585	1	0
Journal Receipts	148	16	4
Country Meeting Receipts:—			
Chelmsford	3261	11	8
	£7692	10	8

Payments during the half-year.

	£.	s.	d.
Permanent Charges	173	0	0
Taxes and Rates	19	9	0
Establishment Charges *	978	2	9
Postage and Carriage	15	15	1
Journal Payments	643	19	9
Essay Prizes	40	0	0
Chemical Grant	150	0	0
Country Meeting Payments:—			
Chelmsford	5212	15	8
Sundry items of Petty Cash	3	14	1
Balance in the hands of the Bankers, Dec. 31, 1856	438	12	8
Petty Cash Balance in the hands of the Secretary, Dec. 31, 1856	17	1	8
	£7692	10	8

(Signed) THOMAS RAYMOND BARKER, *Chairman*,
C. B. CHALLONER,
} *Finance Committee.*
T. W. BRAMSTON, *Trustee.*

Examined, audited, and found correct, the 15th of May, 1857.

(Signed) GEORGE I. RAYMOND BARKER,
GEORGE DYER,
WILLIAM ASTBURY,
} *Auditors on the part of the Society.*

* Under this head is included the sum of 500*l.* paid on account of repairs required in the house of the Society.

SHOW AT SALISBURY: JULY, 1857.

STEWARDS OF THE YARD.

Stewards of Cattle.

Sir Stafford Northcote, Bt.
Samuel Jonas.
Robert Smith.

Stewards of Implements.

Chandos Wren Hoskyns.
Sir Archibald Macdonald, Bt.
Charles Barnett.

Steward of Farm-Poultry.
Philip Pinckney Cother.

Honorary Director of the Show.
B. T. Brandreth Gibbs.

JUDGES.

Short-Horns.

William Bartholomew,
(Thomas Trotter,)
John Wright.

Herefords, Devons, and Other Breeds.

George Williams Baker,
James Tanner Davy,
William Symonds.

Horses.

John Booth,
Samuel Watts.

John Harrison Bland,
William Dickinson.

Leicester Sheep.

Charles Stokes,
William Tindall,
Thomas Twitchell.

Southdown Sheep.

Henry Beauford,
Henry Fookes,
Edward Trumper.

Long-woolled Sheep (not Leicesters).

Henry Beevor,
John Clarke,
Edward Lane Franklin.

Short-woolled Sheep (not Southdowns).

Joseph Blundell,
George Brown,
Thomas Ferris.

Pigs.

Benjamin Swaffield,
Henry Thurnall,
John Unthank.

Farm-Poultry.

George James Andrews,
John Baily.

Implements.

Henry Berney Caldwell,
John Clarke,
William Chalcraft,
Joseph Druce,
Fielder King,
William Owen,
Clare Sewell Read,
John Jephson Rowley.

Veterinary-Inspector.
Professor Simonds,
Royal Veterinary College.

Consulting-Engineer.
Charles Edwards Amos
(Firm of Easton and Amos).

AWARD OF PRIZES.

CATTLE: *Short-horns.*

WILLIAM STIRLING, M.P., of Keir, near Dumblane, Perthshire: the Prize of THIRTY SOVEREIGNS, for his 3 years 5 months and 3 weeks-old roan Short-horned Bull "John o' Groat;" bred by F. H. Fawkes, of Farnley Hall, near Otley, Yorkshire.

JAMES HAUGHTON LANGSTON, M.P., of Sarsden House, near Chipping-Norton, Oxfordshire: the Prize of FIFTEEN SOVEREIGNS, for his 3 years 4 months and 3 days-old roan Short-horned Bull "Gloucester's Grand-Duke;" bred by Henry Hall, of Sesswells-Barton, near Woodstock.

FRANCIS HAWKESWORTH FAWKES, of Farnley Hall, Otley: the Prize of TWENTY-FIVE SOVEREIGNS, for his 1 year 6 months and 3 days-old roan Short-horned Bull "Sir Edmund Lyons;" bred by the exhibitor.

JOHN WASHBOURN BROWN, of Uffcott, near Swindon: the Prize of FIFTEEN SOVEREIGNS, for his 1 year 1 month 3 weeks and 2 days-old roan Short-horned Bull (without name); bred by himself.

STEWART MARJORIBANKS, of Bushey Grove, near Watford: the Prize of TEN SOVEREIGNS for his 8 months and 5 days-old roan Short-horned Bull-calf "Great Mogul;" bred by himself.

RICHARD BOOTH, of Warlaby, near Northallerton: the Prize of FIVE SOVEREIGNS, for his 10 months-old red Short-horned Bull-calf "Lord of the Valley;" bred by himself.

LIEUTENANT-COLONEL CHARLES TOWNELEY, of Towneley Park, Lancashire: the Prize of TWENTY SOVEREIGNS, for his 3 years and 8 months-old red-roan Short-horned Cow, In-milk, "Victoria;" bred by himself.

LIEUTENANT-COLONEL CHARLES TOWNELEY: the Prize of TEN SOVEREIGNS, for his 3 years 3 months 2 weeks and 4 days-old white Short-horned Cow, In-milk, "Vestris the 3rd;" bred by himself.

JAMES DOUGLAS, of Athelstaneford Farm, Drem, East Lothian: the Prize of FIFTEEN SOVEREIGNS, for his 2 years 6 months and 6 days-old roan Short-horned Heifer "Rose of Athelstane;" bred by himself.

RICHARD BOOTH, of Warlaby: the Prize of TEN SOVEREIGNS, for his 2 years 7 months and 3 weeks-old roan In-calf Heifer "Queen of the May;" bred by himself.

LIEUTENANT-COLONEL CHARLES TOWNELEY, of Towneley Park: the Prize of TEN SOVEREIGNS, for his 1 year 10 months and 5 days-old roan Short-horned Heifer "The Rose of Towneley;" bred by himself.

RICHARD BOOTH, of Warlaby: the Prize of FIVE SOVEREIGNS, for his 1 year 8 months and 3 weeks-old roan Short-horned Heifer "Queen Mab;" bred by himself.

CATTLE: *Herefords.*

EDWARD WILLIAMS, of Lowess Court, near Hay, Brecon: the Prize of THIRTY SOVEREIGNS, for his 2 years 8 months 1 week and 2 days-old Hereford Bull "Radnor," dark-brown with white-face and mane; bred by himself.

PHILIP TURNER, of The Leen, Pembridge: the Prize of FIFTEEN SOVEREIGNS, for his 3 years 7 months 2 weeks and 6 days-old Hereford Bull "Silurian," red with white-face; bred by James Rea, of Monaughty.

EDWARD PRICE, of Court House, Pembridge: the Prize of TWENTY-FIVE SOVEREIGNS, for his 1 year 6 months and 5 days-old red-and-white Hereford Bull "Magnet the 3rd;" bred by himself.

RICHARD HILL, of Golding Hall, Shrewsbury: the Prize of FIFTEEN SOVEREIGNS, for his 1 year 6 months and 1 week-old Hereford Bull "Candidate," dark-red with white face; bred by himself.

LORD BATEMAN, of Shobdon Court, Leominster: the Prize of TEN SOVEREIGNS, for his 10 months and 22 days-old white-faced Hereford Bull-Calf "The Captain;" bred by himself.

THOMAS REA, of Westonbury, near Pembridge: the Prize of FIVE SOVEREIGNS, for his 7 months 3 weeks and 6 days-old red white-faced and maned Hereford Bull-calf (without name); bred by himself.

LORD BERWICK, of Cronkhill, Shrewsbury: the Prize of TWENTY SOVEREIGNS, for his 3 years and 4 months-old red white-faced Hereford Cow "Carlisle," In-milk and In-calf; bred by himself.

MRS. ELIZABETH PALMER, of Mudford, near Ilchester: the Prize of TEN SOVEREIGNS, for her 3 years 5 months and 2 weeks-old red-and-white In-calf Hereford Cow "Beauty;" bred by herself.

RICHARD HILL, of Golding Hall: the Prize of FIFTEEN SOVEREIGNS, for his 2 years 8 months 2 weeks and 1 day-old red white-faced In-calf Hereford Heifer "Star;" bred by himself.

PHILIP TURNER, of The Leen, Pembridge: the Prize of TEN SOVEREIGNS for his 2 years 8 months 1 week and 6 days-old red white-faced Hereford Heifer "Graceful," In-milk and In-calf; bred by himself.

EARL OF RADNOR, of Coleshill House, Highworth: the Prize of TEN SOVEREIGNS, for his 1 year and 11 months-old red-and-white Hereford Heifer "Superb;" bred by himself.

LORD BERWICK, of Cronkhill: the Prize of FIVE SOVEREIGNS, for his 1 year 10 months and 6 days-old red white-faced Hereford Heifer "Beauty;" bred by himself.

CATTLE: *Devons.*

JAMES DAVY, of Flitton-Barton, South-Molton: the Prize of THIRTY SOVEREIGNS, for his 3 years 3 months and 2 weeks-old red Devon Bull "Napoleon;" bred by himself.

JOHN BODLEY, of Stockley-Pomeroy, Crediton: the Prize of FIFTEEN SOVEREIGNS, for his 3 years and 4 months-old red Devon Bull "Napoleon;" bred by himself.

JAMES WENTWORTH BULLER, M.P., of Downes, Crediton: the Prize of TWENTY-FIVE SOVEREIGNS, for his 1 year and 6 days-old red Devon Bull (without name); bred by himself.

JOHN C. HALSE, of Molland, Southmolton: the Prize of FIFTEEN SOVEREIGNS, for his 1 year and 8 months-old dark-red North Devon Bull "Sultan, jun.;" bred by himself.

JAMES QUARTLY, of Molland House, Southmolton: the Prize of TEN SOVEREIGNS, for his 7 months and 1 week-old North Devon Bull-Calf "Lord Nelson;" bred by himself.

HIS ROYAL HIGHNESS THE PRINCE CONSORT, of Windsor: the Prize of FIVE SOVEREIGNS, for his 8 months and 3 weeks-old red Devon Bull-Calf "Prince Arthur;" bred by himself.

JAMES QUARTLY, of Molland House: the Prize of TWENTY SOVEREIGNS, for his 5 years 5 months and 2 weeks-old red North Devon Cow "Graceful," In-milk and In-calf; bred by himself.

JAMES QUARTLY, of Molland House: the Prize of TEN SOVEREIGNS, for his 5 years 6 months and 2 weeks-old red North Devon Cow "Sylph," In-milk and In-calf; bred by himself.

EDWARD POPE, of Great Toller, Dorsetshire: the Prize of FIFTEEN SOVEREIGNS, for his 2 years and 7 months-old red In-calf Devon Heifer "Fancy;" bred by himself.

JAMES HOLE, of Knowle House, Dunster: the Prize of TEN SOVEREIGNS, for his 2 years 7 months and 1 week-old red In-calf Devon Heifer (without name); bred by himself.

JAMES QUARTLY, of Molland House: the Prize of TEN SOVEREIGNS, for his 1 year 7 months and 2 weeks-old red In-calf North Devon Heifer "Fancy;" bred by himself.

WILLIAM MULLINGS GIBBS, of Bishop's-Lydeard, Taunton: the Prize of FIVE SOVEREIGNS, for his 1 year 2 months and 2 weeks-old red Devon Heifer (without name); bred by himself.

CATTLE: *Channel Islands.*

ALEXANDER ELPHINSTON, of Chuten Glen, Christchurch, Hampshire: the Prize of TEN SOVEREIGNS, for his (about) 5 years-old black-and-white Jersey Bull "Premier;" breeder unknown (the animal purchased of Michael Fowler, at Bushey Farm, Watford, in August, 1855).

[No entry for the Prize of FIVE SOVEREIGNS offered for the best Bull calved since the 1st of January, 1856, and more than 1 year old.]

HENRY COMBE COMPTON, of Manor House, Lyndhurst: the Prize of FIVE SOVEREIGNS, for his 6 years and 1 month-old red-and-white Guernsey Cow, In-milk and In-calf (without name); bred by himself.

JAMES BECKINGHAM, of Dell Farm, Church-Oakley, Hampshire: the Prize of FIVE SOVEREIGNS, for his 1 year 11 months and 10 days-old grey-and-white Channel Islands In-calf Heifer "Beauty;" bred by himself.

LEONARD PITT MATON, of Haddington, Devizes: the Prize of FIVE SOVEREIGNS, for his 1 year 11 months and 2 weeks-old white-and-black-spotted In-milk Jersey Heifer "Blink Bonny;" bred by himself.

CATTLE: *Other established Breeds.*

[No entry for the two Prizes of TEN SOVEREIGNS each offered for Bulls in this division.]

THOMAS ROBERT BROOK CARTWRIGHT, of Aynhoe, Brackley: the Prize of TEN SOVEREIGNS, for his 4 years 3 months 3 weeks and 4 days-old black Polled Angus In-calf Cow (without name); bred by himself.

[No entry for the Prize of TEN SOVEREIGNS offered for the best In-milk or In-calf Heifer not exceeding 3 years old.]

REV. MORTON SHAW, of Rougham Rectory, Bury St. Edmunds: the Prize of FIVE SOVEREIGNS, for his 1 year 2 months 3 weeks and 4 days-old red Suffolk Heifer (without name); bred by himself.

HORSES.

THOMAS BLACKBURN THOROTON HILDYARD, of Flintham Hall, Newark: the Prize of THIRTY SOVEREIGNS, for his 6 years-old dapple-grey agricultural Stallion "Matchless;" bred by Thomas Hayto, of Sempringham Fen, Falkingham, Lincolnshire; sire, "King of the Country, or Farmer's Glory;" dam, without name.

WILLIAM and THOMAS BAKER, of Bury Farm, Stapleford, Cambridgeshire: the Prize of TWENTY SOVEREIGNS, for their 4 years and 3 months-old dark-grey Suffolk-and-Lincoln Agricultural Stallion "Young Inkermann;" bred by Peter Grain, jun., of Great Shelford; sire, "Heart of Oak;" dam, without name.

SAMUEL CLAYDEN, of Little Linton, Cambridgeshire: the Prize of TWENTY SOVEREIGNS, for his 2 years and 2 months-old chesnut Suffolk Agricultural Stallion "Royal George;" bred by himself; sire, "Old Samson;" dam, "Depper."

WILLIAM WILSON, of Baylham Hall, Ipswich, Suffolk: the Prize of TEN SOVEREIGNS, for his 2-years old chesnut Suffolk Agricultural Stallion "Young Duke;" bred by Sir Edward Kerrison, Bart., M.P., of Broom Hall, near Eye; sire, "Catlin's Duke;" dam, without name.

SAMUEL WOLTON, jun., of Kesgrave, Woodbridge, Suffolk: the Prize of TWENTY SOVEREIGNS, for his 10 years-old chesnut Suffolk Agricultural Mare "Bouny," with her Foal; breeder of the mare unknown (purchased at 2 years old of Robert Parker, of Badwell Ash, Suffolk).

SAMUEL WRINCH, of Great-Holland, Colchester: the Prize of TEN SOVEREIGNS, for his 6 years-old chesnut Suffolk Agricultural Mare "Brock," with her Foal; breeder of the mare unknown (purchased of a dealer when 1 year old).

WILLIAM LONG, of Amesbury, Wiltshire: the Prize of FIFTEEN SOVEREIGNS, for his 2 years 2 months and 8 days-old chesnut Agricultural Filly "Judy;" bred by himself; sire, "Tomboy;" dam, "Punch."

SAMUEL WRINCH, of Great Holland: the Prize of TEN SOVEREIGNS, for his 2 years-old chesnut Suffolk Agricultural Filly (without name); bred by Leonard Wrinch, jun., of Little Oakley, Harwich; sire, "Duke;" dam, "Brock."

WILLIAM BULLER, jun., of Hanwell Fields, Banbury: the Prize of FIFTEEN SOVEREIGNS, for his 6 years-old brown Oxfordshire Dray Stallion "The Conqueror;" bred by John White of America; sire, "Lion;" dam, "Brown."

LORD ST. JOHN, of Melchbourne, Higham Ferrers: the Prize of TEN SOVEREIGNS, for his 2 years-old roan Dray Stallion "Charley;" bred by himself; sire, "Lion;" dam, "Smiler."

JAMES RAWLENCE, of Bulbridge, Wilton, Wiltshire: the Prize of TEN SOVEREIGNS, for his 8 years-old brown Dray Mare "Darling," with her Foal; breeder unknown (purchased of a railway contractor).

[No competition (one entry) for the Prize of FIVE SOVEREIGNS offered for the best Dray Filly foaled in the year 1855.]

THOMAS GROVES, of Plompton Hall, Knaresborough: the Prize of THIRTY SOVEREIGNS, for his 8 years-old bay Thorough-bred Stallion "Hobbie Noble," for getting hunters; bred by Lord John Scott; sire, "Pantaloon;" dam, "Phryne;" sire of dam, "Touchstone."

THOMAS MANFIELD, of Thirkleby Bridge, Thirsk: the Prize of TWENTY SOVEREIGNS, for his 5 years-old bay Thorough-bred Stallion "Spencer," for getting hunters; bred by Colonel Archdall, of Castle Archdall, Ireland; sire, "Cotherstone;" dam, "Polka;" sire of dam, "Emilius."

JAMES GODWIN, of Allington, Devizes: the Prize of TWENTY SOVEREIGNS, for his 11 years-old brown "nearly or quite" Thorough-bred Stallion "Hotspur," for getting hackneys; bred by himself; sire, "Sir Hercules;" dam out of "Dexterous's" dam; sire of dam, "Rajah."

THOMAS FRASER GROVE, of Seagry House, Chippenham: the Prize of TWENTY SOVEREIGNS for his 13 years-old dark-brown Irish Mare "Speculation," for breeding hunters; breeder not stated (bought in 1847 of John de Montmorency, of Castle Morres, county Kilkenny); sire, "Elwas."

JOHN BAYNTUN STARKY, of Spye Park, Chippenham: the Prize of FIFTEEN SOVEREIGNS, for his 17 years-old bay Mare "Caper," for breeding hackneys; bred by the late J. E. A. Starky, of Spye Park; sire, "Peregrine."

SHEEP: *Leicesters.*

WILLIAM SANDAY, of Holme Pierrepoint, Nottingham: the Prize of TWENTY-FIVE SOVEREIGNS, for his 1 year and 4 months-old Shearling Leicester Ram; bred by himself; sire, "M. U.;" sire of dam, "D. H."

WILLIAM SANDAY, of Holme Pierrepoint: the Prize of FIFTEEN SOVEREIGNS, for his 1 year and 4 months-old Shearling Leicester Ram; bred by himself; sire, "W. H.;" sire of dam, "Y. H."

WILLIAM SANDAY, of Holme Pierrepoint: the Prize of TWENTY-FIVE SOVEREIGNS, for his 3 years and 4 months-old Leicester Ram; bred by himself; sire, "W. H.;" sire of dam, "Y."

WILLIAM SANDAY, of Holme Pierrepoint: the Prize of FIFTEEN SOVEREIGNS, for his 3 years and 4 months-old Leicester Ram; bred by himself; sire, "No. 1;" sire of dam, "D. R."

WILLIAM SANDAY, of Holme Pierrepoint: the Prize of TWENTY SOVEREIGNS, for his 1 year and 4 months-old Pen of five Shearling Leicester Ewes; bred by himself.

WILLIAM SANDAY, of Holme Pierrepoint: the Prize of TEN SOVEREIGNS, for his 1 year and 4 months-old Pen of five Shearling Leicester Ewes; bred by himself.

SHEEP: *Southdowns.*

JONAS WEBB, of Babraham, Cambridgeshire: the Prize of TWENTY-FIVE SOVEREIGNS, for his 1 year and 3½ months-old Shearling Southdown Ram; bred by himself.

JONAS WEBB, of Babraham: the Prize of FIFTEEN SOVEREIGNS, for his 1 year and 4 months-old Shearling Southdown Ram; bred by himself.

JONAS WEBB, of Babraham: the Prize of TWENTY-FIVE SOVEREIGNS, for his 2 years and 4 months-old Southdown Ram; bred by himself.

JONAS WEBB, of Babraham: the Prize of FIFTEEN SOVEREIGNS, for his 2 years and 4 months-old Southdown Ram; bred by himself.

HENRY OVERMAN, of Weasenham, Norfolk: the Prize of TWENTY SOVEREIGNS, for his 1 year and 4 months-old Pen of five Shearling Southdown Ewes; bred by himself.

HENRY OVERMAN, of Weasenham: the Prize of TEN SOVEREIGNS, for his 1 year and 4 months-old Pen of five Shearling Southdown Ewes; bred by himself.

SHEEP: *Long-wools (not Leicesters).*

WILLIAM LANE, of Broadfield Farm, Northleach: the Prize of TWENTY-FIVE SOVEREIGNS, for his 16 months-old Shearling Cotswold Ram; bred by himself.

WILLIAM LANE, of Broadfield Farm: the Prize of FIFTEEN SOVEREIGNS, for his 16 months-old Shearling Cotswold Ram; bred by himself.

EDWARD HANDY, of Sierford, Cheltenham: the Prize of TWENTY-FIVE SOVEREIGNS, for his 3 years 3 months and 2 weeks-old Cotswold Ram; bred by himself.

WILLIAM GARNE, of Aldsworth, Northleach: the Prize of FIFTEEN SOVEREIGNS, for his 3 years and 4 months-old Cotswold Ram; bred by himself.

WILLIAM GARNE, of Aldsworth: the Prize of TWENTY SOVEREIGNS, for his 1 year and 4 months-old Pen of five Shearling Cotswold Ewes; bred by himself.

WILLIAM LANE, of Broadfield Farm: the Prize of TEN SOVEREIGNS, for his 16 months-old Pen of five Shearling Cotswold Ewes: bred by himself.

GEORGE ADNEY, of Harley, Much-Wenlock, Shropshire: the Prize of TWENTY-FIVE SOVEREIGNS, for his 1 year and 4 months-old "original Shropshire" Shearling Ram; bred by himself.

WILLIAM HUMFREY, of Oak Ash, Wantage, Berkshire: the Prize of FIFTEEN SOVEREIGNS, for his 1 year and 4½ months-old "improved Hampshire Down" Shearling Ram; bred by himself.

SAMUEL MEIRE, of Castle Hill, Much-Wenlock: the Prize of TWENTY-FIVE SOVEREIGNS, for his 3 years and 5 months-old "improved Shropshire Down" Ram "Magnet;" bred by himself.

GEORGE ADNEY, of Harley, Shropshire: the Prize of FIFTEEN SOVEREIGNS, for his 3 years and 4 months-old "original Shropshire Down" Ram; bred by himself.

WILLIAM BROWNE CANNING, of Chisledon, Swindon: the Prize of TWENTY SOVEREIGNS, for his 1 year and 4 months-old Pen of five "improved Hampshire Down" Shearling Ewes; bred by himself.

WILLIAM ROWDEN SHITTLER, of Bishopston, near Salisbury: the Prize of TEN SOVEREIGNS, for his 1 year and 5 months-old Pen of five Shearling Hampshire Down Ewes; bred by himself.

PIGS.

JOHN HARRISON, jun., of Heaton-Norris, near Stockport, Lancashire: the Prize of TEN SOVEREIGNS, for his 1 year 8 months 2 weeks and 6 days-old large white-spotted Boar "Young Carswell;" bred by J. Carswell, of Butley, Macclesfield.

JOSEPH TULEY, of Truewell Farm, near Keighley, Yorkshire: the Prize of FIVE SOVEREIGNS, for his 2 years-old large white Boar "Plato;" bred by William Leake, of North Cliff, Market-Weighton.

GEORGE MANGLES, of Givendale, near Ripon, Yorkshire: the Prize of TEN SOVEREIGNS, for his 2 years and 3 months-old small-breed white Yorkshire Boar "Bendigo;" bred by himself.

LIEUTENANT-COLONEL CHARLES TOWNELEY, of Towneley Park, Lancashire: the Prize of FIVE SOVEREIGNS, for his (about) 1 year-old small white Boar "Young Joe;" bred by himself.

WILLIAM HEWER, of Sevenhampton, Wiltshire: the Prize of TEN SOVEREIGNS, for his 5 years and 4 months-old black-and-white large Breeding Sow "Duchess;" bred by himself.

JOHN HARRISON, jun., of Heaton-Norris: the Prize of FIVE SOVEREIGNS, for his 2 years and 3 months-old white-and-spotted large Breeding Sow "Victory;" bred by J. Hardwick, of Levenshulme, near Manchester.

ROBERT HARRISON WATSON, of Bolton Park, Wigton, Cumberland: the Prize of TEN SOVEREIGNS, for his 2 years 7 months 3 weeks and 5 days-old small white Breeding Sow "Faith;" bred by himself.

THOMAS CRISP, of Butley Abbey, Woodbridge, Suffolk: the Prize of FIVE SOVEREIGNS, for his 2 years and 1 month-old small black Breeding Sow (without name); bred by himself.

GEORGE BOWES MORLAND, of Abingdon, Berkshire: the Prize of TEN SOVEREIGNS, for his 7 months 1 week and 3 days-old Pen of three white (blue spotted) "Improved Chilton" Sow-Pigs, of large breed; bred by himself.

ROBERT HARRISON WATSON, of Bolton Park: the Prize of TEN SOVEREIGNS, for his 7 months 3 weeks and 2 days-old Pen of three white Breeding Sow-Pigs "We," "Must," "Win," of small breed; bred by himself.

FARM POULTRY: *Dorkings.*

CAPTAIN WILLIAM WINDHAM HORNBY, R.N., of Knowsley Cottage, Prescot: the Prize of FIVE SOVEREIGNS, for his 5 months and 1 day-old grey Dorking Cock and two Pullets; bred by himself.

JOHN DALE HEWSON, M.D., of Coton Hill, Stafford; the Prize of THREE SOVEREIGNS, for his grey or slate-coloured Dorking Cock (5 months and 2 weeks old) and two Pullets (4 months and 2 weeks old); bred by himself.

George Botham, of Wexham Court, Slough: the Prize of Two Sovereigns, for his 5 months 2 weeks and 1 day-old, dark-grey Dorking Cock and two Pullets; bred by John Baily, of Mount-street.

Robert Loder, of The High Beeches, Crawley: the Prize of One Sovereign, for his 5 months 3 weeks 4 days-old grey or speckled Dorking Cock and two Pullets; bred by Mrs. Chart and Henry Peters.

Captain Hornby, R.N., of Knowsley Cottage: the Prize of Five Sovereigns, for his (above) 1 year-old grey Dorking Cock and two Hens; bred by himself.

George Botham, of Wexham Court: the Prize of Three Sovereigns, for his grey Dorking Cock (2 years and 6 months old) and two Hens (3 years old); cock bred by the Rev. J. Boys, and one hen by H. D. Davies; the breeder of the other hen unknown.

Rev. Thomas Lyon Fellowes, of Beighton Rectory, Acle: the Prize of Two Sovereigns, for his grey Dorking Cock and Hen (1 year and 6 months old), and another Hen (1 year and 1 month old) bred by himself.

Henry Smith, of the Grove, Cropwell-Butler, Notts: the Prize of One Sovereign, for his 2 years 1 month 3 weeks and 4 days-old grey or speckled Dorking Cock and two Hens; bred by himself.

Captain Hornby, R.N., of Knowsley Cottage: the Prize of Two Sovereigns, for his (above) 1 year-old grey Dorking Cock; bred by himself.

William Fisher Hobbs, Boxtead Lodge, Colchester: the Prize of One Sovereign, for his 2 years and 2 months-old grey Dorking Cock; bred by himself.

Farm Poultry: *Spanish.*

George Botham, of Wexham Court: the Prize of Five Sovereigns for his 2 years-old black, white, and red Spanish Cock and two Hens; breeder unknown.

Captain Hornby, R.N., of Knowsley Cottage: the Prize of Three Sovereigns, for his (about) 1 year-old black Spanish Cock and two Hens; the Hens bred by himself, the breeder of the Cock unknown.

Joseph Kilvert Bartrum, of Richmond Hill, Bath: the Prize of Two Sovereigns for his black Spanish Cock (17 months old) and two Hens (about 3 years old); breeder unknown.

John Kersley Fowler, of Prebendal Farm, Aylesbury: the Prize of One Sovereign for his 18 weeks-old black Spanish Cock and two Hens; bred by himself.

Joseph Kilvert Bartrum, of Bath: the Prize of Two Sovereigns, for his 18 months-old black Spanish Cock; breeder unknown.

Farm Poultry: *Cochin-China.*

John Kersley Fowler, of Prebendal Farm: the Prize of Four Sovereigns, for his 16 weeks-old white Cochin-China Cock and two Pullets; bred by himself.

John Kersley Fowler: the Prize of Two Sovereigns for his 16 weeks-old buff Cochin-China Cock and two Pullets; bred by himself.

Henry Fookes, of Whitechurch, Blandford: the Prize of Four Sovereigns, for his buff Cochin-China Cock (3 years and about 3 months old) and two Hens (1 year and about 3 months old); the Hens bred by himself, the breeder of the Cock unknown.

Rev. Grenville Frodsham Hodson, of North Petherton: the Prize of Two Sovereigns, for his 2 years and 1 month-old buff Cochin-China Cock and two Hens; bred by the Rev. F. Shields, of North Petherton.

Rev. Grenville Frodsham Hodson, of North Petherton: the Prize of Two Sovereigns, for his (above) 2 years-old Partridge Cochin-China Cock; bred by himself.

Farm Poultry: *Brahma-Pootra.*

George Botham, of Wexham Court: the Prize of Two Sovereigns, for his grey-pencilled Brahma-Pootra Cock and Hen (3 years old), and another Hen (4 years old); the Cock and one Hen bred by himself, the other Hen by J. Allison, of Acton.

Farm Poultry: *Game.*

Captain Hornby, R.N., of Knowsley Cottage: the Prize of Five Sovereigns, for his (above) 1 year-old red Game Cock and two Hens; bred by himself.

James Crane, Jun., of Tolpuddle, Dorchester: the Prize of Three Sovereigns, for his 3 years-old black-breasted red Game Cock and two Hens; bred by himself.

Thomas Pain, of Laverstock Hall, near Salisbury: the Prize of Two Sovereigns, for his 3 years-old grey duck-wing Game Cock and two Hens; bred by A. Blake, of Salisbury.

Thomas Parker Mew, of West Cowes, Isle of Wight: the Prize of One Sovereign, for his (about) 1 year and 4 months-old, brown, red, or duck-wing Game Cock and two Hens; bred by himself and C. Allen.

George Caleb Adkins, of West House, Edgbaston, Birmingham: the Prize of Two Sovereigns, for his (about) 1 year and 2 months-old black-breasted red Game Cock; breeder unknown.

Farm Poultry: *Hamburg.*

Rev. Thomas Lyon Fellowes, of Beighton Rectory: the Prize of Two Sovereigns, for his 1 year 3 months and 2 weeks-old, yellowish buff or bay golden-pencilled Hamburg Cock and two Hens; bred by himself.

John Lowe, of Whitmore House, Birmingham: the Prize of One Sovereign, for his 1 year and 3 months-old golden-pencilled Hamburg Cock and two Hens; bred by himself.

George Botham, of Wexham Court: the Prize of Two Sovereigns, for his 1 year and 2 months-old silver-pencilled Hamburg Cock and two Hens; bred by himself.

Thomas Parker Mew, of West Cowes, Isle of Wight: the Prize of One Sovereign, for his (about) 1 year 3 months-old silver-pencilled Hamburg Cock and two Hens; bred by himself.

William Alfred Elston, of Bugbrook, Weedon: the Prize of Two Sovereigns, for his 2 years and 1 week-old golden-spangled Hamburg Cock and two Hens; bred by himself.

George Caleb Adkins, of West House: the Prize of One Sovereign for his 1 year and 3 months-old golden-spangled Cock and two Hens; bred by himself.

Rev. Thomas Lyon Fellowes, of Beighton Rectory: the Prize of Two Sovereigns, for his 1 year and 2 months-old white Hamburg Cock and two Hens, spangled with bright-green-black; bred by himself.

Joseph Kilvert Bartrum, of Bath: the Prize of One Sovereign, for his 1 year and 3 months-old silver-spangled Cock and two Hens; breeder unknown.

Farm Poultry: *Malay.*

Charles Ballance, of Mount Terrace, Taunton: the Prize of Two Sovereigns, for his 1 year 4 months and 2 weeks-old black-breasted grouse Malay Cock and two Hens: bred by himself.

FARM POULTRY: *Poland.*

JOHN JAMES FOX, of Devizes: the Prize of FOUR SOVEREIGNS, for his 3 years and 2 months-old golden-spangled Poland Cock and two Hens; the Cock bred by John Conyers, Jun., of Leeds, and the Hens by the exhibitor.

[No Entry for the Prize of Two Sovereigns for the second-best golden Polands.]

JOHN JAMES FOX, of Devizes: the Prize of FOUR SOVEREIGNS, for his 1 year and 1 month-old silver-spangled Poland Cock and two Hens: bred by C. E. Coleridge, of Eton.

GEORGE CALEB ADKINS, of West House: the Prize of TWO SOVEREIGNS, for his 2 years and 3 months-old silver-spangled Poland Cock and two Hens; bred by himself.

GEORGE RAY, of Ivy Cottage, Minesteed, near Lyndhurst: the Prize of FOUR SOVEREIGNS, for his 1 year 2 months 1 week and 5 days-old white-crested black Poland Cock and two Hens; bred by himself.

GEORGE CALEB ADKINS, of West House: the Prize of TWO SOVEREIGNS, for his 3 years and 2 months-old white-crested black Poland Cock and two Hens; breeder unknown.

FARM POULTRY: *Turkeys.*

Rev. THOMAS LYON FELLOWES, of Beighton Rectory: the Prize of THREE SOVEREIGNS, for his 1 year 2 months and 2 weeks-old grey Cambridgeshire Turkey Cock and two Hens; bred by himself.

HENRY FOOKES, of Whitechurch, Blandford: the Prize of ONE SOVEREIGN, for his brown Cambridge Turkey Cock (1 year 4 months and 2 days old) and two Hens (2 years and 3 months old); the Cock bred by himself, the Hens by Sir Edward B. Baker, Bart., of Ranston.

FARM POULTRY: *Geese.*

JOHN KERSLEY FOWLER, of Aylesbury: the Prize of THREE SOVEREIGNS, for his 2 years and 3 months-old white and mottled Gander and two Geese; bred by himself.

JOHN KERSLEY FOWLER: the Prize of TWO SOVEREIGNS, for his 13 weeks-old white and mottled Gander and two Geese; bred by himself.

HENRY FOOKES, of Whitechurch, Blandford: the Prize of ONE SOVEREIGN, for his 13 weeks and 4 days-old grey Gander and two Geese; bred by himself.

FARM POULTRY: *Ducks.*

JOHN KERSLEY FOWLER, of Aylesbury: the Prize of THREE SOVEREIGNS, for his 1 year and 3 months-old pure white Aylesbury Drake and two Ducks; bred by himself.

JOHN KERSLEY FOWLER: the Prize of TWO SOVEREIGNS, for his 14 weeks-old pure white Aylesbury Drake and two Ducks; bred by himself.

JOHN KERSLEY FOWLER: the Prize of ONE SOVEREIGN, for his 18 weeks-old pure white Aylesbury Drake and two Ducks; bred by himself.

JOHN KERSLEY FOWLER: the Prize of THREE SOVEREIGNS, for his 13 weeks-old Rouen Drake and two Ducks; bred by himself.

HENRY FOOKES, of Whitechurch, Blandford: the Prize of TWO SOVEREIGNS, for his 13 weeks-old brown Rouen Drake and two Ducks; bred by himself.

JOHN KERSLEY FOWLER: the Prize of ONE SOVEREIGN, for his Rouen Drake and two Ducks; bred by himself.

John Kersley Fowler: the Prize of Two Sovereigns, for his 1 year and 1 month-old black East-Indian Drake and two Ducks; bred by himself.

Rev. Frederick Bell Pryor, of Bennington Rectory, Stevenage: the Prize of One Sovereign, for his 1 year and 3 months-old black East-Indian Drake and two Ducks; bred by himself.

Special Prizes,

For Hampshire-Down Sheep:

OFFERED BY THE SALISBURY LOCAL COMMITTEE.

William Humfrey, of Oak-Ash, Chaddleworth, Berkshire: the Prize of Twenty Sovereigns, for his 1 year and $4\frac{1}{2}$ months-old Hampshire-Down Shearling Ram; bred by himself.

William Humfrey, of Oak-Ash: the Prize of Ten Sovereigns, for his 1 year and $5\frac{1}{2}$ months-old Hampshire-Down Shearling Ram; bred by himself.

William Humfrey, of Oak-Ash: the Prize of Twenty Sovereigns, for his 3 years and $3\frac{1}{2}$ months-old Hampshire-Down Ram; bred by himself.

Stephen King, of Old Hayward Farm, Hungerford: the Prize of Ten Sovereigns, for his 3 years and 5 months-old Hampshire-Down Ram; bred by himself.

John Thomas Francis Pain, of North-Houghton Manor, Stockbridge: the Prize of Twenty Sovereigns, for his 4 months and 2 weeks-old pen of five Hampshire-Down Ram-Lambs; bred by himself.

Robert Coles, of Middleton Farm, Norton-Bavant, Warminster: the Prize of Ten Sovereigns, for his 4 months and 3 weeks-old pen of five Hampshire Down Ram-Lambs; bred by himself.

William Browne Canning, of Chisledon, Swindon: the Prize of Twenty Sovereigns, for his 1 year and 4 months-old pen of five Shearling Hampshire-Down Ewes; bred by himself.

Edward Waters, of Stratford-sub-Castle, near Salisbury: the Prize of Ten Sovereigns, for his 1 year and 5 months-old pen of five Shearling Hampshire Down Ewes; bred by himself.

Special Prize,

For the best Polled Bull of any age, Exhibited at the Salisbury Meeting:

OFFERED BY M. DUTRÔNE,

Demeurant au Château de Sarlabot, Trousseauville, Dives (Calvados).

George David Badham, of the Sparrow's Nest, Ipswich: the Special Prize of M. Dutrône's Gold Medal, of the value of Five Sovereigns, for his 2 years and 2 months-old red Suffolk Bull "Sarlabot;" bred by himself: sire, "Canrobert."

Commendations.

The mark * signifies "HIGHLY COMMENDED;" the mark † "COMMENDED" (distinctly and individually); and the omission of these marks, "GENERALLY COMMENDED" (as part of a whole class).

CATTLE.

*RICHARD STRATTON, of Broad-Hinton, Swindon: for his 6 years and 5 months-old In-calf roan Short-horned Cow "Matchless the 2nd;" bred by himself.

*RICHARD STRATTON: for his 3 years 5 months 3 weeks and 1 day-old In-calf and In-milk roan Short-horned Cow; bred by himself.

*RICHARD BOOTH, of Warlaby, Northallerton: for his 4 years 3 months and 3 weeks-old In-calf and In-milk white Short-horned Cow "Bride-Elect;" bred by himself.

*RICHARD BOOTH: for his 3 years 2 months 3 weeks and 4 days-old In-calf and In milk roan Short-horned Cow "Nectarine Blossom;" bred by himself.

*THOMAS WETHERELL, of Aldbrough, Darlington: for his 4 years 3 months and 5 days-old In-calf roan Short-horned Cow "Moss Rose;" bred by William Harrison, of Kirkband, Darlington.

*JAMES HAUGHTON LANGSTON, M.P.: for his 7 years and 1 month-old In-calf and In-milk red-roan Short-horned Cow "Champion;" bred by himself.

*RICHARD STRATTON, of Broad-Hinton: for his 2 years and 3 months-old In-calf roan Short-horned Heifer "Blush Rose;" bred by himself.

*LIEUTENANT-COLONEL CHARLES TOWNELEY: for his 1 year 2 months and 2 days-old white Short-horned Yearling Heifer "Beauty's Butterfly;" bred by himself.

*JAMES DOUGLAS, of Athelstaneford: for his 1 year 2 months and 4 days-old roan Short-horned Yearling Heifer "3rd Queen of Trumps;" bred by himself.

*LIEUTENANT-COLONEL CHARLES TOWNELEY: for his 1 year 7 months 1 week and 1 day-old roan Short-horned Yearling Heifer "Bracelet;" bred by himself.

JOHN WASHBOURNE BROWN, of Uffcott, Swindon: for his 2 years 4 months 3 weeks and 2 days-old In-calf roan Short-horned Heifer (without name); bred by himself.

WILLIAM JEFFERYS, of Maiden-Bradley: for his 2 years and 5 months-old In-calf red Short-horned Heifer "Red Rose;" bred by himself.

LIEUTENANT-COLONEL TOWNELEY: for his 2 years 2 months 3 weeks and 1 day-old In-calf roan Short-horned Heifer "Eugénie;" bred by himself.

CHARLES BARNETT, of Stratton Park, Biggleswade: for his 2 years 6 months 1 week and 1 day-old In-calf red (with a little white) Short-horned Heifer "Moldavia the 1st;" bred by himself.

CHARLES BARNETT, of Stratton Park: for his 2 years 2 months 3 weeks and 1 day-old In-calf light-roan Short-horned Heifer "Moldavia the 3rd;" bred by himself.

WILLIAM TOD, of Elphinstone Tower, Tranent, East Lothian: for his 2 years and 10 weeks-old In-calf roan Short-horned Heifer "Nanie;" bred by Robert Syme, of Redkirk.

RICHARD STRATTON, of Broad-Hinton: for his 1 year 4 months and 2 days-old roan Short-horned Yearling Heifer "Matchless the 5th;" bred by himself.

RICHARD STRATTON: for his 1 year and 4 months-old roan Short-horned Yearling Heifer "Coquette the 2nd;" bred by himself.

CHARLES ORMSTON EATON, of Tixover Hall, Stamford: for his 1 year 4 months 1 week and 5 days-old (colour not stated) Short-horned Yearling Heifer "Czarina;" bred by the Rev. Thomas Cator, of Skelbrook Park.

JOHN HALL, of Kiveton Park, Worksop: for his 1 year 7 months 1 week and 2 days-old white Short-horned Yearling Heifer "Elegance;" bred by himself.

SAMUEL CLOUGH, of Florida Cottage, Ashton, Lancashire: for his 1 year 1 month 3 weeks and 6 days-old light-roan Short-horned Yearling Heifer "Moss Rose;" bred by himself.

THOMAS HENRY NOEL HILL, of Berrington, Shrewsbury: for his 1 year 8 months and 1 week-old roan Short-horned Yearling Heifer "Lady Rockingham;" bred by the Hon. and Rev. H. Noel Hill.

JOHN SHATTOCK, of Parsonage Farm, Long-Ashton: for his 1 year 5 months and 2 weeks-old roan-and-white Short-horned Yearling Heifer "Lizzy;" bred by C. H. Abbot.

WILLIAM HEWER, of Sevenhampton, Wilts: for his 1 year 3 months and 2 weeks-old roan Short-horned Yearling Heifer "Mathilda;" bred by himself.

WILLIAM HEWER: for his 1 year 3 months and 3 weeks-old roan Short-horned Heifer "Rosette;" bred by himself.

WILLIAM JEFFREYS, of Maiden-Bradley: for his 1 year and 3 months-old roan Short-horned Yearling Heifer "Venus;" bred by himself.

WILLIAM JEFFREYS: for his 1 year and 5 months-old light-red Short-horned Yearling Heifer "Beauty;" bred by himself.

CAPTAIN ROBERT GUNTER (4th Drag. Guards), of Wetherby Grange, Yorkshire: for his 1 year 10 months 1 week and 3 days-old roan Short-horned Yearling Heifer "Autumn Rose;" bred by himself.

JOHN R. MIDDLEBROUGH, of South-Milford, Yorkshire: for his 1 year 2 months 3 weeks and 4 days-old roan Short-horned Yearling Heifer "Princess Royal;" bred by himself.

JOHN BOYNTUN STARKY, of Spye Park, Chippenham: for his 1 year and 2 months-old roan-and-white Short-horned Yearling Heifer; bred by himself.

†RICHARD HILL, of Golding Hall, Shrewsbury: for his 2 years 9 months and 2 weeks-old grey Hereford Bull "Master Henry;" bred by Henry Hill, of Shiffnal.

†WILLIAM STYLES POWELL (representatives of the late), of Hinton Court, Hereford: for his 2 years and 11 months-old In-calf red (white-faced) Hereford Heifer "Fatima;" bred by Walter Maybery, of Penllann, Brecon.

†JAMES WALKER, of Northleach: for his 2 years 8 months and 6 days-old In-calf red (white-faced) Hereford Heifer "Miss David Chance the 5th;" bred by William Raester, of Thinghill.

*JAMES REA, of Monaughty, Radnorshire: for his 1 year 7 months 3 weeks and 1 day-old dark-red (white-faced and shouldered) Hereford Yearling Heifer "Heiress;" bred by himself.

WALTER MAYBERY, of Brecon: for his 1 year and 10 months-old red (white-faced) Hereford Yearling Heifer "Flora;" bred by himself.

WALTER MAYBERY: for his 1 year and 5 months-old red (white-faced) Hereford Yearling Heifer "Gwenny;" bred by himself.

WALTER MAYBERY: for his 1 year and 9 months-old red (white-faced) Hereford Yearling Heifer; bred by himself.

WALTER MAYBERY: for his 1 year and 9 months-old red (white-faced and loined) Hereford Yearling Heifer "Hebe;" bred by himself.

WILLIAM PERRY, of Cholstrey, Leominster: for his 1 year 6 months 1 week and 3 days-old red-and-white (dark-spotted) Hereford Yearling Heifer "Young Pretty Maid;" bred by himself.

WILLIAM PERRY: for his 1 year 7 months and 2 days-old red-and-white Hereford Yearling Heifer "Young Duchess;" bred by himself.

STEPHEN MILLS, of Elston, Devizes: for his 1 year and 2 weeks-old red (white-faced) Hereford Yearling Heifer "Snowball;" bred by himself.

STEPHEN MILLS: for his 1 year and 2 months-old red (white-faced) Hereford Yearling Heifer "Frolic;" bred by himself.

THOMAS DUCKHAM, of Baysham Court, Ross: for his 1 year 11 months 3 weeks and 4 days-old red-and-white Hereford Yearling Heifer "Jewel;" bred by Edmund Lewis, of Breinton.

THOMAS REA, of Westonbury, Pembridge: for his 1 year 7 months 1 week and 2 days-old red (white-faced and maned) Hereford Yearling Heifer "Fair Maid;" bred by James Rea, of Monaughty.

THOMAS REA: for his 1 year and 7 months-old red (white-faced and maned) Hereford Yearling Heifer "Young Cherry;" bred by James Rea.

HENRY HIGGINS, of Woolaston Grange, Sydney: for his 1 year 8 months and 10 days-old red (white-faced) Hereford Yearling Heifer "Hopbine;" bred by William Raester, of Thinghill.

HENRY HIGGINS: for his 1 year 7 months and 3 weeks-old red (white-faced) Hereford Yearling Heifer; bred by William Raester.

WILLIAM STYLES POWELL (representatives of the late): for his 1 year 4 months

and 6 days-old red (white-faced) Hereford Yearling Heifer "Miss Noble;" bred by himself.

WILLIAM STYLES POWELL (representatives of the late): for his 1 year 7 months 1 week and 3 days-old red (white-faced) Hereford Yearling Heifer "Lady 2nd;" bred by himself.

PHILIP TURNER, of The Leen, Pembridge: for his 1 year 10 months and 1 day-old red (white-faced) Hereford Yearling Heifer "Maythorn;" bred by himself.

*WILLIAM MULLINGS GIBBS, of Bishop's Lydeard, Taunton: for his 3 years and 6 months-old red Devon Bull (without name); bred by himself.

†JAMES DAVY, of Flitton-Barton, Southmolton: for his 6 months and 2 weeks-old red Devon Bull-Calf "Hero;" bred by himself.

*HIS ROYAL HIGHNESS THE PRINCE CONSORT, of Windsor; for his 6 years and 6 months-old red In-calf Devon Cow "Verbena;" bred by George Turner, of Barton, near Exeter.

*WILLIAM MULLINGS GIBBS, of Bishop's Lydeard: for his 7 years and 7 months-old red In-milk and In-calf Devon Cow "Daisy;" bred by himself.

*GEORGE TURNER, of Barton, near Exeter: for his 7 years 1 month and 2 weeks-old red In-milk and In-calf Devon Cow "Heart's-ease;" bred by himself.

EDWARD POPE, of Great Toller, Dorchester: for his 5 years 4 months and 2 weeks-old red In-milk and In-calf Devon Cow "Fancy (702);" bred by himself.

THOMAS WHITE FOURACRE, of Durston, Taunton: for his 4 years and 10 months-old red In-calf Devon Cow "Young Cowslip;" bred by himself.

WILLIAM BAKER, of Purewell House, Christchurch, Hampshire: for his 3 years 2 months 2 weeks and 6 days-old red In-milk and In-calf Devon Cow "Cherry;" bred by himself.

Rev. CECIL SMITH, of Lydeard House, Taunton: for his 5 years and 6 months-old red In-milk Devon Cow "Bertha;" bred by himself.

WALTER FARTHING, of Stowey Court, Bridgewater: for his 4 years and 5 months-old red In-milk and In-calf Devon Cow "Fancy;" bred by himself.

WALTER FARTHING: for his 6 years and 1 month-old red In-milk and In-calf Devon Cow "Lovely;" bred by J. Harper, of Chaddon, Taunton.

THOMAS WHITE FOURACRE, of Durston: for his 6 years and 2 months-old red In-milk Devon Cow "Pretty Maid;" bred by himself.

JAMES HOLE, of Knowle House, Dunster: for his 4 years 5 months and 1 week-old red In-milk and In-calf Devon Cow "Prize-Flower;" bred by himself.

†EDWARD POPE, of Great Toller: for his 2 years and 4 months-old red In-calf Devon Heifer "Primrose;" bred by himself.

†EDWARD POPE: for his 2 years and 5 months-old red In-calf Devon Heifer "Famous;" bred by himself.

†GEORGE TURNER, of Barton: for his 2 years 4 months and 2 weeks-old red In-calf Devon Heifer "Piccolomini;" bred by himself.

*JOHN C. HALSE, of Molland, Southmolton: for his 1 year and 7 months-old dark-red Devon Yearling Heifer "Princess;" bred by himself.

†HIS ROYAL HIGHNESS THE PRINCE CONSORT, of Windsor: for his 1 year 1 month 2 weeks and 3 days-old red Devon Yearling Heifer "Ilex;" bred by himself.

†ARTHUR WILLIAM CRISP, of Chillesford, Woodbridge: for his 4 years and 3 months-old red In-milk Suffolk Cow "Rose;" bred by himself.

HORSES.

*HENRY OGDEN, of Ashton, near Stamford: for his 4 years and 3 months-old brown Agricultural Stallion "Ploughboy;" bred by himself.

*MANFRED BIDDELL, of Playford, near Ipswich: for his 5 years-old chesnut Agricultural Suffolk Stallion "Major;" bred by himself.

*WILLIAM WILSON, of Baylham Hall, Ipswich: for his 5 years-old chesnut Agricultural Suffolk Stallion "Duke;" bred by Robert Kersey, of Hadleigh.

*NATHANIEL GEORGE BARTHROPP, of Cretingham Rookery, Woodbridge: for his 9 years-old chesnut Agricultural Suffolk Stallion "Hercules;" bred by J. Green, of Fenringhoo, Colchester.

*NATHANIEL GEORGE BARTHROPP: for his 4 years-old chesnut Agricultural Suffolk Stallion "The Hero;" bred by M. Crisp, of Letheringham, Woodbridge.

*JOHN GOBBITT, of Sudbourne, near Woodbridge: for his 2 years and 2 months-old chesnut Agricultural Suffolk Stallion "Young Briton;" bred by himself.

*JOHN WARD, of East Mersea, near Colchester: for his 2 years 2 months and 3 weeks-old chesnut Agricultural "pure" Suffolk Stallion "Boxer;" bred by Carleton Smythies, of Roman Hill, Colchester.

*GEORGE DAVID BADHAM, of The Sparrow's Nest, Ipswich: for his 2 years-old chesnut Agricultural Stallion "Young Captain;" bred by himself.

*JOHN WILLSHEIRE POND, of Great Totham Hall, Witham: for his 2 years-old chesnut Agricultural Suffolk Stallion "Emperor;" bred by himself.

*THOMAS CRISP, of Butley Abbey, Woodbridge: for his 2 years-old chesnut Agricultural Suffolk Stallion; bred by J. Read, of Laxfield, Suffolk.

*WILLIAM FOWLE, of Market-Lavington: for his 8 years-old roan Agricultural North-Country Mare "Violet," with her foal; bred by himself.

*JOHN WELTON GOBBITT, of Iken Hall, Saxmundham: for his (about) 9 years-old chesnut Agricultural Suffolk Mare "Depper," with her foal; bred by John Gobbitt, of Sudbourn.

*FREDERICK LAVINGTON, of Chitterne-All-Saints, Heytesbury: for his 7 years-old chesnut Agricultural Suffolk Mare "Sorrel," with her foal; bred by himself.

*JOHN WARD, of East Mersea: for his 6 years-old chesnut Agricultural "pure" Suffolk Mare "Diamond," with her foal: bred by the late James Tillet, of Braiswick, near Colchester.

*WILLIAM FITT CORDERY, of Hazeley Farm, near Winchester: for his 8 years and 2 months-old grey Agricultural Hampshire Mare "Whitefoot," with her foal; bred by Thomas Cordery.

*Rev. JOHN GUY COPLESTON, of Offwell, near Honiton: for his 8 years-old black Agricultural Herefordshire Mare "Frolic," with her foal; breeder unknown.

*LORD ST. JOHN, of Melchbourne, Higham-Ferrers: for his 9 years-old brown Agricultural Northamptonshire Mare "Nell," with her foal; breeder unknown.

*GEORGE CARTER, of Danbury, Chelmsford: for his 2 years-old bright-chesnut Agricultural Suffolk Filly "Ruby;" bred by James King, of Great Bardfield, Essex.

*WILLIAM CURNICK, of Sleight Farm, Potterne, near Devizes: for his 2 years 3 weeks and four days-old black (white hind-footed) Agricultural Filly "Black Bess;" bred by himself.

†THOMAS HIBBARD, of Bishopston, near Faringdon: for his 5 years-old brown Agricultural Stallion "Farmer's Delight;" bred by himself.

†GEORGE MUMFORD SEXTON, of Earl's Hall, Cockfield, near Sudbury: for his 3 years-old chesnut Agricultural "pure" Suffolk Stallion "The Chelmsford Champion;" bred by James Josselyn, of Copdock, near Ipswich.

†JOHN WILLIAMS, of Trimley-St.-Martin, Ipswich: for his 3 years and 1 month-old chesnut Agricultural Suffolk Stallion, "Champion;" bred by himself.

†JOHN PORTER, of Coln-St.-Aldwine, near Fairford: for his 2 years and 2 months-old bright-bay (black-legged) Agricultural Stallion "Cotswold;" bred by himself.

†THOMAS HIBBARD, of Bishopston, near Faringdon: for his 2 years-old bay Agricultural Stallion "Wiltshire Champion;" bred by himself.

†JOHN WARD, of East-Mersea: for his 2 years 2 months and 3 weeks-old chesnut Agricultural "pure" Suffolk Stallion "Young Colonel;" bred by himself.

†JOSHUA RODWELL, of Alderton Hall, Woodbridge: for his 2 years and 2 months-old bay Agricultural Stallion "Buccaneer;" bred by himself.

†STEPHEN MILLS, of Elston: for his 2 years and 2 months-old dark-grey Agricultural Stallion "The Emperor;" bred by himself.

†SAMUEL BIDMEAD, of Tunley, near Cirencester: for his 3 years-old dark-bay Agricultural Mare "Diamond," with her foal; bred by himself.

†THOMAS BROWN, of Horton, near Devizes: for his 9 years-old grey Agricultural Mare "Rose," and her foal; bred by himself.

†SAMUEL WOLTON, JUN., of Kesgrave, near Woodbridge: for his 2 years-old chesnut Agricultural Suffolk Filly "Empress;" bred by himself.

†Nathaniel George Barthropp, of Cretingham Rookery: for his 2 years-old chesnut Agricultural Suffolk Filly (without name); bred by himself.

*Stephen Kirby, of Mill House, Thirsk: for his 7 years-old bay Thorough-bred Stallion for getting hunters "Stotforth;" bred by himself.

*Richard James Webb, of Reading: for his aged Thorough-bred Stallion for getting Hunters "Master Robin;" bred by J. Maxwell, of Ireland.

†Alexander Elphinston, of Chuten Glen, Christchurch, Hampshire: for his (about) 10 years-old grey Arabian Thorough-bred Stallion "Long Trump," for getting hunters; breeder unknown (the horse having been bred by the Arabs in the desert of Arabia, and imported thence into Bombay).

†Alexander Elphinston: for his (about) 9 years-old chesnut Arabian Stallion "Arab-Cob," for getting hackneys; breeder unknown (the horse having been bred by the Arabs in the desert of Arabia, imported to Bombay, and thence to England, passing through different hands).

Rev. Thomas Best, of Red-Rice, near Andover: for his brown Mare, adapted for breeding hunters; breeder unknown.

Thomas Townley Parker, of Astley Hall, Chorley: for his 16 years-old brown Mare "Mistletoe," adapted for breeding hunters; breeder unknown.

Thomas Rea, of Westonbury, Pembridge: for his 6 years-old dark-chesnut Nag-Mare "Sultana," adapted for breeding hunters; bred by David Rogers, of Rodd, near Presteign, Radnorshire.

Thomas Pain, of Laverstock Hall, near Salisbury: for his 15 years-old brown Mare "Polly," adapted for breeding hunters; supposed to have been bred by Lord Gardner.

William Tod, of Elphinstone Tower: for his 9 years-old chesnut Mare "Meg," adapted for breeding hunters; breeder unknown.

Edward St. John, of Oakley, Basingstoke: for his 15 years-old brown Mare "Mary Blane," for breeding hunters; bred by the Duke of Beaufort at Badminton.

Sheep.

†William Sanday, of Holme-Pierrepoint: for his 3 years and 4 months-old Leicester Ram; bred by himself.

†William Sanday: for his 4 years and 4 months-old Leicester Ram; bred by himself.

†William Sanday: for his 4 years and 4 months-old Leicester Ram; bred by himself.

†Lord Berners, of Keythorpe Hall, Tugby: for his 3 years 2 months 1 week and 4 days-old Leicester Ram; bred by himself.

†Thomas Edward Pawlett, of Beeston, Bedfordshire: for his 2 years and 4 months-old Leicester Ram; bred by himself.

†Thomas Edward Pawlett, of Beeston, Bedfordshire: for his 2 years and 4 months-old Leicester Ram; bred by himself.

†Robert Ward Creswell, of Ravenstone, near Ashby-de-la-Zouch; for his 3 years and 4 months-old Leicester Ram; bred by himself.

†*Jonas Webb, of Babraham: for his 1 year and 3½ months-old Shearling Southdown Ram; bred by himself.

†*Jonas Webb: for his 1 year and 4 months-old Shearling Southdown Ram; bred by himself.

*Jonas Webb: for his 1 year and 4 months-old Shearling Southdown Ram; bred by himself.

*Jonas Webb: for his 1 year and 4 months-old Shearling Southdown Ram; bred by himself.

*William Rigden, of Hove, near Brighton: for his 2 years 4 months and 2 weeks-old Southdown Ram; bred by himself.

*Jonas Webb: for his 2 years and 4 months-old Southdown Ram; bred by himself.

*William Sainsbury, of Hunts House, West-Lavington: for his 16 months-old pen of five Shearling Southdown Ewes; bred by himself.

*Lord Walsingham, of Merton Hall, Thetford: for his 15 months and 2 weeks-old pen of five Shearling Southdown Ewes; bred by himself.

*William Lucas, of East Coker, near Yeovil: for his 1 year and 4 months-old pen of five Shearling Southdown Ewes; bred by himself.

*The Duke of Richmond, of Goodwood, near Chichester: for his 1 year 4 months and 2 weeks-old pen of five Shearling Southdown Ewes; bred by himself.

[*Note made by the Judges.*—"This pen appears to be worthy of high commendation; but the ewes do not appear to be in a state that would allow us sufficiently to examine them." The state of the sheep, to which the Judges refer, was the result of injuries which the animals had sustained by accidental fire on the railway.]

†Lord Walsingham; for his 15 months and 2 weeks-old Shearling Southdown Ram; bred by himself.

†The Duke of Richmond: for his 1 year 4 months and 2 weeks-old Shearling Southdown Ram; bred by himself.

†The Duke of Richmond: for his 1 year 4 months and 2 weeks-old Shearling Southdown Ram; bred by himself.

†Henry Overman, of Weasenham, near Rougham: for his 1 year and 4-months-old Shearling Southdown Ram; bred by himself.

†Henry Overman: for his 2 years and 4 months-old Southdown Ram; bred by himself.

†Henry Overman: for his 2 years and 4 months-old Southdown Ram; bred by himself.

†Earl of Radnor, of Coleshill House, Highworth: for his 1 year and 4 months-old pen of five Shearling Southdown Ewes; bred by T. Northeast, of Tedworth, near Marlborough.

†Lord Walsingham: for his 15 months and 2 weeks-old pen of five Shearling Southdown Ewes; bred by himself.

*George Fletcher, of Shipton-Sollars, Cheltenham: for his one year 3 months and 2 weeks-old Cotswold Shearling Ram; bred by himself.

*Thomas Porter, of Baunton, Cirencester: for his 16 months-old Shearling Cotswold Ram; bred by himself.

*William Garne, of Aldsworth, Northleach: for his 1 year and 4 months-old Cotswold Shearling Ram; bred by himself.

*Thomas Beale Browne, of Hampen, Andoversford, Gloucestershire: for his 2 years 3 months and 2 weeks-old Cotswold Ram; bred by himself.

*Thomas Beale Browne: for his 2 years 3 months and 2 weeks-old Cotswold Ram; bred by himself.

*William Hewer, of Hill House, Northleach: for his 3 years and 4 months-old Cotswold Ram; bred by himself.

*William Lane, of Broadfield Farm, Northleach: for his 52 months-old Cotswold Ram; bred by himself.

*Thomas Walker, of Yanworth, near Northleach: for his 2 years and 3 months-old Cotswold Ram; bred by himself.

*William Hewer, of Hill House, Northleach: for his 1 year and 4 months-old Pen of five Shearling Cotswold Ewes; bred by himself.

*William Lane, of Broadfield Farm, Northleach: for his 16 months-old Pen of five Shearling Cotswold Ewes; bred by himself.

†William Hewer, of Hill House: for his 1 year and 4 months-old Shearling Cotswold Ram; bred by himself.

†William Hewer: for his 1 year and 4 months-old Shearling Cotswold Ram; bred by himself.

†Thomas Beale Browne, of Hampen: for his 1 year 3 months and 2 weeks-old Shearling Cotswold Ram; bred by himself.

†George Fletcher, of Shipton-Sollars, Cheltenham: for his 3 years 3 months and 2 weeks-old Cotswold Ram; bred by himself.

†John Howell, of Ewen, Cirencester: for his 3 years and 4 months-old Cotswold Ram; bred by himself.

†Thomas Beale Browne: for his 1 year 3 months and 2 weeks-old Pen of five Shearling Cotswold Ewes; bred by himself.

†Thomas Beale Browne: for his 1 year 3 months and 2 weeks-old Pen of five Shearling Cotswold Ewes; bred by himself.

Lewin Arnold, of Tormarton, Chippenham: for his 1 year and 4 months-old Shearling Cotswold Ram; bred by himself.

LEWIN ARNOLD: for his 1 year and 4 months-old Shearling Cotswold Ram; bred by himself.
LEWIN ARNOLD: for his 1 year and 4 months-old Shearling Cotswold Ram; bred by himself.
LEWIN ARNOLD: for his 1 year and 4 months-old Shearling Cotswold Ram; bred by himself.
EDWARD HANDY, of Sierford: for his 1 year 3 months and 2 weeks-old Shearling Cotswold Ram; bred by himself.
EDWARD HANDY: for his 1 year 3 months and 2 weeks-old Shearling Cotswold Ram; bred by himself.
EDWARD HANDY: for his 1 year 3 months and 2 weeks-old Shearling Cotswold Ram; bred by himself.
THOMAS BEALE BROWNE: for his 1 year 3 months and 2 weeks-old Shearling Cotswold Ram; bred by himself.
THOMAS BEALE BROWNE: for his 1 year 3 months and 2 weeks-old Shearling Cotswold Ram; bred by himself.
THOMAS BEALE BROWNE: for his 1 year 2 months and 2 weeks-old Shearling Cotswold Ram; bred by himself.
THOMAS LITTLE, of Biddestone, Chippenham: for his 16 months-old Shearling Cotswold Ram; bred by himself.
JOHN KING TOMBS, of Langford, near Leehlade: for his 1 year and 4 months-old Shearling Cotswold Ram; bred by himself.
JOHN KING TOMBS: for his 1 year and 4 months-old Shearling Cotswold Ram; bred by himself.
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JOHN KING TOMBS: for his 1 year 2 months and 2 weeks-old Shearling Cotswold Ram; bred by himself.
GEORGE FLETCHER, of Shipton-Sollars, Cheltenham: for his 1 year 3 months and 2 weeks-old Shearling Cotswold Ram; bred by himself.
GEORGE FLETCHER: for his 1 year 3 months and 2 weeks-old Shearling Cotswold Ram; bred by himself.
WILLIAM HEWER, of Hill House: for his 1 year and 4 months-old Shearling Cotswold Ram; bred by himself.
WILLIAM HEWER: for his 1 year and 4 months-old Shearling Cotswold Ram; bred by himself.
WILLIAM HEWER: for his 1 year and 4 months-old Shearling Cotswold Ram; bred by himself.
WILLIAM LANE, of Broadfield Farm: for his 16 months-old Shearling Cotswold Ram; bred by himself.
WILLIAM LANE: for his 16 months-old Shearling Cotswold Ram; bred by himself.
WILLIAM LANE: for his 16 months-old Shearling Cotswold Ram; bred by himself.
JOHN LANE, of Barton Hills, Cirencester: for his 1 year and 4 months-old Shearling Cotswold Ram; bred by himself.
JOHN LANE: for his 1 year and 4 months-old Shearling Cotswold Ram; bred by himself.
JOHN LANE: for his 1 year and 4 months-old Shearling Cotswold Ram; bred by himself.
JOHN LANE: for his 1 year and 4 months-old Shearling Cotswold Ram; bred by himself.
THOMAS PORTER, of Baunton, Cirencester: for his 16 months-old Cotswold Ram; bred by himself.
THOMAS PORTER: for his 16 months-old Shearling Cotswold Ram; bred by himself.
WILLIAM GARNE, of Aldsworth, Northend: for his 1 year and 4 months-old Shearling Cotswold Ram; bred by himself.
WILLIAM GARNE: for his 1 year and 4 months-old Shearling Cotswold Ram; bred by himself.
WILLIAM GARNE: for his 1 year and 4 months-old Shearling Cotswold Ram; bred by himself.

WILLIAM GARNE: for his 1 year and 4 months-old Shearling Cotswold Ram; bred by himself.

WILLIAM SMITH, of Bibury, near Fairford: for his 1 year 3 months and 2 weeks-old Shearling Cotswold Ram; bred by himself.

WILLIAM SMITH, of Bibury; for his 1 year 3 months and 2 weeks-old Shearling Cotswold Ram; bred by himself.

EDMUND RUCK, of Castle Hill, Cricklade: for his 1 year and 4 months-old Shearling Cotswold Ram "Stonehenge;" bred by himself.

†GEORGE ADNEY, of Harley, near Much-Wenlock: for his 1 year and 4 months-old Shearling "Original Shropshire" Southdown Ram; bred by himself.

†WILLIAM HUMFREY, of Oak-Ash, Chaddleworth, Berkshire: for his 1 year and 5½ months-old Shearling Hampshire Down Ram; bred by himself.

†WILLIAM HUMFREY, of Oak-Ash: for his 3 years and 3½ months old Hampshire Down Ram; bred by himself.

†JOHN WASHBOURNE BROWN, of Uffcott, near Swindon: for his 3 years 5 months and 3 weeks-old Hampshire Down Ram; bred by himself.

*WILLIAM ROWDEN SHITTLER, of Bishopston, near Salisbury: for his 1 year and 5 months-old Pen of five Shearling Hampshire Down Ewes; bred by himself.

†JOHN THOMAS FRANCIS PAIN, of North Houghton Manor, Stockbridge: for his 1 year 4 months and 1 week-old Pen of five Shearling Hampshire Down Ewes; bred by himself.

PIGS.

*HENRY BLANDFORD, of Sandridge, Chippenham: for his 3 years and 3 months-old black (white-faced and footed) Berkshire large-breed Boar "Sandridge;" bred by himself.

*EARL OF PORTSMOUTH, of Hurstbourne Park, Whitchurch, Hampshire: for his 1 year 11 months and 3 weeks-old black Essex small-bred Boar "Othello;" bred by the Rev. Morton Shaw, of Rougham Rectory.

*JOHN PALMER, of Thorlby, near Skipton: for his 1 year 11 months 1 week and 3 days-old white Breeding-Sow "Victoria," of a large breed; bred by himself.

*JOHN PALMER: for his 2 years and 2 months-old white Breeding-Sow "Bella," of a small breed; bred by Lieut.-Colonel Towneley, of Towneley Park.

*SOLOMON ASHTON, of Peter Street, Manchester: for his 7 months and 3 days-old Pen of three white (blue-skinned) Breeding Sow-Pigs "The belles of Mauchline," of a large breed; bred by himself.

*GEORGE MANGLES, of Givendale, near Ripon: for his 7 months and 2 weeks-old Pen of three white Breeding Sow-Pigs "Faith, Hope, and Charity," of a small breed; bred by himself.

*MANFRED BIDDELL, of Playford, near Ipswich: for his 6 months and 4 days-old Pen of three white Breeding Sow-Pigs "Playford, Ipswich, and Suffolk," of a small breed; bred by himself.

†REV. GRENVILLE FRODSHAM HODSON, of North-Petherton: for his 8 months and 2 days-old black Improved-Leicester Boar "Pompey," of a small breed; bred by J. French, of Haw, near Bridgwater.

†THOMAS HORSFALL, of Burley Hall, near Otley: for his 1 year 2 months and 22 days-old small white Boar (without name); bred by himself.

†THOMAS HORSFALL: for his 1 year 2 months and 22 days-old small white Boar "Wharfdale Lad;" bred by himself.

†JOSEPH TULEY, of Truewell Farm, Keighley: for his (about) 3 years and 2 months-old large white Breeding-Sow "Miss Nightingale;" bred by Joseph Bland, of Keighley.

†JOHN CALVERT, of Skipton: for his 2 years and 11 months-old large white (two-spotted) Breeding-Sow "Bess;" bred by J. Beauland, of Skipton.

†GEORGE MANGLES, of Givendale: for his 2 years 4 months and 1 week-old small white Yorkshire Breeding-Sow "Bracelet;" bred by himself.

†GEORGE MANGLES: for his 1 year 4 months and 1 week-old small white Yorkshire Breeding-Sow; bred by himself.

†GEORGE TURNER, of Barton, near Exeter: for his 1 year and 8 months-old small black Improved-Essex Breeding-Sow (without name); bred by himself.

†REV. HENRY GEORGE BAILY, of Swindon Vicarage, Wilts: for his 6 months and

3 weeks-old Pen of three black (white-spotted) Improved-Berkshire Breeding Sow-Pigs, of a large breed; bred by himself.

†MRS. ELIZABETH PALMER, of Mudford, near Ilehester: for her 7 months-old Pen of three black Essex Breeding Sow-Pigs; bred by herself.

WILLIAM LOVERING BRAILEY, of Corffe Farm, Tavistock, near Barnstaple: for his 1 year 9 months 1 week and 3 days-old small black Breeding-Sow "Gipsy Queen;" bred by himself.

GEORGE MANGLES, of Givendale: for his 4 years and 11 months-old small white Yorkshire Breeding-Sow "Miss Brown, 2nd B;" bred by himself.

GEORGE MANGLES: for his 2 years and 3 months-old small white Yorkshire Breeding-Sow "Beauty;" bred by himself.

GEORGE MANGLES. for his 11 months and 3 weeks-old small white Yorkshire Breeding-Sow "Miss Brown, 4th B;" bred by himself.

GEORGE MANGLES: for his 7 months 1 week and 3 days-old small white Yorkshire Breeding-Sow "Lydia;" bred by himself.

EARL OF RADNOR, of Coleshill House: for his 24 weeks-old small Coleshill Breeding-Sow; bred by himself.

EARL OF RADNOR: for his 36 weeks and 2 days-old small Coleshill Breeding-Sow; bred by himself.

ROBERT HARRISON WATSON, of Bolton Park, Wigton: for his 1 year and 8 months-old small white Breeding-Sow "Kiss-me-quick;" bred by himself.

HENRY SCOTT HAYWARD: of Folkington, near Willingdon, Sussex: for his 1 year 1 week and 5 days-old small white Breeding-Sow "Primrose;" bred by himself.

HENRY SCOTT HAYWARD: for his 1 year 1 month and 2 weeks-old small white Breeding-Sow "Queen of the Downs;" bred by himself.

WILLIAM HATTON, of Addingham. near Otley: for his 1 year 2 months 1 week and 4 days-old small white Breeding-Sow "Matchless;" bred by himself.

WILLIAM HATTON: for his 1 year 9 months and 2 weeks-old small white Breeding-Sow "Queen of Diamonds;" bred by himself.

ROBERT LODER, of the High Beeches, Crawley: for his 1 year 1 month 3 weeks and 5 days-old small black Improved-Essex Breeding-Sow "Princess;" bred by himself.

WILLIAM MARDEN, of Pen Mills, near Yeovil: for his 1 year and 11 months-old small black Breeding-Sow "Nonpareil;" bred by himself.

WILLIAM MARDEN: for his 1 year and 11 months-old small black Breeding-Sow "Countess;" bred by himself.

DUKE OF BEAUFORT, of Bodminton: for his 10 months and 2 weeks-old small white Breeding-Sow; bred by himself.

RICHARD CROSSLEY, of Leverton Place, Manchester: for his 2 years and 1 week-old "pure-small-breed" white Breeding-Sow "Matchless;" bred by Solomon Ashton.

JOHN HARRISON, JUN., of Heaton-Norris, near Stockport: for his 2 years 11 months 2 weeks and 2 days-old small white Breeding-Sow "Jenny Lind;" bred by himself.

THOMAS PAIN, of Laverstock Hall, near Salisbury: for his 1 year and 2 months-old small black Hammoon-Dorset Breeding-Sow; bred by himself.

GEORGE TURNER, of Barton, near Exeter: for his 3 months-old small black Improved-Essex Breeding-Sow; bred by himself.

JAMES JOHN FARQUHARSON, of Langton, near Blandford: for his 2 years and 7 months-old small black Essex Breeding-Sow; bred by himself.

JOHN GROVE, of Ferne House, near Salisbury: for his 3 years and 6 months-old small white Wiltshire Breeding-Sow; bred by himself.

JOHN GROVE: for his 1 year and 2 months-old small white Wiltshire Breeding-Sow; bred by William Dick, of Gunville-Tarrant, Blandford.

REV. GRENVILLE FRODSHAM HODSON: for his 1 year 2 months 1 week and 5 days-old small black Improved-Leicester Breeding-Sow "Stella;" bred by himself.

SAMUEL MUNRO, of East-Stanley Street, Salford: for his 2 years 1 week and 3 days-old small white Breeding-Sow "Molly;" bred by himself.

REV. MORTON SHAW, of Rougham Rectory, Bury-St.-Edmunds: for his 11 months 1 week and 1 day-old small black Improved West-Suffolk Breeding-Sow; bred by himself.

REV. MORTON SHAW: for his 1 year and 2 weeks-old small black Improved West-Suffolk Breeding-Sow; bred by himself.

REV. MORTON SHAW: for his 1 year 2 weeks and 2 days-old small black Improved West-Suffolk Breeding-Sow; bred by himself.

LIEUT.-COLONEL CHARLES TOWNELEY: for his 1 year 1 month and 2 weeks-old small white Breeding-Sow "Nancy;" bred by himself.

JAMES MARRIOTT, of Floore, near Weedon: for his 1 year 6 months and 2 weeks-old small white Improved Leicester-and-Yorkshire Breeding-Sow "Miss Fanny;" bred by himself.

JAMES MARRIOTT: for his 3 years and 10 months-old small white Improved Leicester-and-Yorkshire Breeding-Sow; bred by Samuel Wiley, of Bransby, near York.

JAMES MARRIOTT: for his 1 year 1 week and 6 days-old small white Improved Leicester-and-Yorkshire Breeding Sow; bred by himself.

GEORGE EDWARD TAYLOR, of Oatlands, near Leeds: for his 11 months 3 weeks and 2 days-old small white Improved Yorkshire Breeding-Sow "Julie;" bred by J. B. Stead, of Leeds.

JOSEPH WILKINSON, of Roundhay, near Leeds: for his 1 year 3 months and 1 week-old small white Breeding-Sow "Julia;" bred by himself.

JOSEPH WILKINSON: for his 1 year 3 months and 1 week-old small white Breeding-Sow "Janet;" bred by himself.

JOSEPH WILKINSON: for his 1 year 3 months and 1 week-old small white Breeding-Sow "Jenny;" bred by himself.

THOMAS CRISP, of Butley Abbey, Woodbridge: for his 3 years and 3 months-old small white Suffolk Breeding-Sow "Snow-flake;" bred by himself.

THOMAS CRISP: for his 2 years and 1 month-old small black Breeding-Sow; bred by himself.

THOMAS CRISP: for his 3 years and 4 months-old small black Breeding-Sow "Black Diamond;" bred by himself.

THOMAS CRISP: for his 3 years and 1 month-old small white Suffolk Breeding-Sow; bred by himself.

HARRY CURTIS, of Hill Farm, Fordingbridge: for his 3 years and 2 months-old small white Yorkshire Breeding-Sow "The Queen of Sheba;" bred by George Mangles, of Givendale.

WILLIAM FISHER HOBBS, of Boxted Lodge, Colchester: for his 3 years and 4 months-old small black Improved-Essex Breeding-Sow; bred by himself.

WILLIAM FISHER HOBBS: for his 2 years and 4 months-old small black Improved-Essex Breeding-Sow; bred by himself.

WILLIAM FISHER HOBBS: for his 2 years and 4 months-old small black Improved-Essex Breeding-Sow; bred by himself.

WILLIAM FISHER HOBBS: for his 10 months 1 week and 5 days-old small black Improved-Essex Breeding-Sow; bred by himself.

WILLIAM FISHER HOBBS: for his 10 months 1 week and 5 days-old small black Improved-Essex Breeding-Sow; bred by himself.

WILLIAM FISHER HOBBS: for his 10 months 1 week and 5 days-old small black Improved Essex Breeding-Sow; bred by himself.

WILLIAM BAKER, of Parewell House, Christchurch: for his 6 months 3 weeks and 5 days-old small black Improved Hampshire Breeding-Sow "Dinah;" bred by himself.

WILLIAM BAKER: for his 3 years-old small black Improved-Hampshire Breeding-Sow "Dinah;" bred by John Coate, of Hammoon, near Sturminster.

[*Show of Pigs.*—The Judges of Pigs have recorded the following general opinion on their department of the Exhibition at Salisbury:—"We think the show of Pigs remarkably good."]

FARM-POULTRY.

†*ROBERT LODER, of The High Beeches, Crawley: for his 5 months 3 weeks and 4 days-old grey coloured Dorking Cock and two Pullets; bred by Mrs. Chart, of Monk's Gate Farm, Horsham, and Henry Peters, of Ashfold, near Crawley.

†*JOHN KERSLEY FOWLER, of Prebendal Farm, Aylesbury: for his 18 weeks-old white Dorking Cock and two Pullets; bred by W. Burtt, of Weston-Turville, Bucks.

†*John Kersley Fowler: for his 22 weeks-old grey coloured Dorking Cock and two Pullets; bred by himself.

†*Christopher Smith, of Great Durnford, near Salisbury: for his 14 weeks-old coloured Dorking Cock and two Pullets; bred by himself.

†*Mrs. Jane M. St. John, of Oakley, near Basingstoke: for her 5 months and 3 days-old grey Dorking Cock and two Pullets; bred by herself.

†*William Henry Woodcock, of Foulstone, near Wilton: for his 3 months-old grey Dorking Cock and two Pullets; bred by himself.

†*Francis Leyborne Popham, of Littlecott, near Hungerford: for his 2 months 3 weeks and 1 day-old brown Dorking Cock and two Pullets; bred by himself.

†*Robert Loder, of the High Beeches, Crawley: for his 2 years and 2 months-old grey or speckled Dorking Cock and two Hens; bred by himself.

†*Robert Loder: for his 2 years and 2 months-old grey Dorking Cock and two Hens; bred by himself.

†*John James Fox, of Devizes: for his (about) 3 years-old grey Dorking Cock and two Hens; bred by W. Wright, of Widness, near Warrington.

†*Christopher Smith, of Great Durnford: for his 1 year and 4 months-old coloured Dorking Cock, and his 1 year and 3 months-old two coloured Dorking Hens; the Cock bred by W. Rouse, of Wickham-Market, and the Hens by the exhibitor.

†*Thomas Porter, of Baunton, Cirencester: for his 1 year and 3 months-old grey speckled Dorking Cock and two Hens; bred by J. Lawrence, of Greenway, Cheltenham.

†*Henry Fookes, of Whitechurch, Blandford: for his (more than) 1 year-old grey coloured Dorking Cock and two Hens; the breeder of the Cock stated to be unknown, the Hens bred by the Exhibitor.

†*Henry Smith, of The Grove, Cropwell-Butler, Notts, for his grey Dorking Cock and two Hens; the Cock 3 years and 1 month old and bred by Dr. Hitchman, of Mickleoom, Derby; the Hens respectively 3 years 2 months 1 week and 2 days old, and 2 years 1 month 2 weeks and 3 days, and bred by the exhibitor.

†*William Henry Woodcock, of Foulstone, near Wilton: for his 1 year and 2 months-old grey Dorking Cock and two Hens; the Cock bred by Robert Loder, of the High Beeches, and the Hens by the exhibitor.

†*Rev. John Leyborne Popham, of Chilton Rectory, Hungerford: for his 1 year and 3 months-old dark-grouse coloured Dorking Cock, bred by himself; and his two 2 years and 3 months-old dark-grouse coloured Dorking Hens, bred by the Rev. S. Donne, of Oswestry.

†*John Kersley Fowler, of Prebendal Farm, Aylesbury; for his 15 weeks-old partridge or grouse Cochin-China Cock and two Pullets; bred by himself.

†*John Kersley Fowler: for his 18 weeks-old white Cochin-China Cock and two Pullets; bred by himself.

†*John Thompson, of Badminton, Chippenham: for his 4 months and 1 week-old partridge-coloured Cochin-China Cock and two Pullets; bred by himself.

†*John Weston, of Aylesbury: for his 5 months and 1 week-old white Cochin-China Cock and two Pullets; bred by himself.

†*Rev. Grenville Frodsham Hodson: for his 5 months-old partridge Cochin-China Cock and two Pullets; bred by himself.

†*Henry Fookes, of Whitechurch, Blandford: for his 15 weeks and 2 days-old buff Cochin-China Cock and two Pullets; bred by himself.

†*Henry Fookes: for his 13 weeks and 2 days-old buff Cochin-China Cock and two Pullets; bred by himself.

*John Kersley Fowler: for his 1 year and 2 months-old white Cochin-China Cock and two Hens; bred by himself.

*John Thompson, of Badminton: for his (about) 4 years-old buff-coloured Cochin-China Cock and Hen, bred by the late Earl of Ducie; and his (about) 2 years and 2 months-old buff-coloured Cochin-China Hen, bred by the late Joseph Neeld, M.P.

*George Caleb Adkins, of West House, Edgbaston: for his 2 years and 3 months-old partridge Cochin-China Cock and two Hens; breeder stated to be unknown.

*Rev. Grenville Frodsham Hodson: for his (above) 1 year-old partridge-coloured Cochin-China Cock and two Hens; bred by himself.

*Mrs. Mary Parker, of Coalstaith, near Brampton, Cumberland: for her 2 years and 1 month-old buff Cochin-China Cock and two Hens; bred by herself.

*Rev. Thomas Lyon Fellowes, of Beighton Rectory, Acle: for his (supposed to be about) 3 years-old black Cochin-China Cock and two Hens; believed to have been bred in Yarmouth, and probably by J. Preston, or from his stock.

*Charles Punchard, of Blunt's Hall, Haverhill: for his (above) 1 year-old partridge Cochin-China Cock and two Hens; the Cock bred by Captain Fell, of St. Swithin's Lane, London; the Hens by the exhibitor.

*Charles Punchard: for his (above) 1 year old buff Cochin-China Cock and two Hens; bred by himself.

*William Henry Woodcock, of Foulstone: for his (above) 1 year-old buff Cochin-China Cock and two Hens; bred by himself.

*John James Fox, of Devizes: for his 1 year and 2 months-old duckwing Game Cock and two Hens; bred by himself.

*John James Fox: for his (about) 1 year and 4 months-old black-breasted red Game Cock, bred by W. Cox, of Brailsford, near Derby; and his two 1 year and 3 months-old black-breasted red Game Hens, bred by Henry Brown, of Monckton, near Swindon.

*Tertius Thomas Burman, of Lynn, near Walsall: for his 1 year and 3 months-old black-breasted red Game Cock and two Hens; bred by himself.

*Mrs. Mary Parker, of Coalstaith: for her 2 years-old black-breasted red Game-cock and two partridge-coloured Game Hens; bred by herself.

*Thomas Porter, of Baunton: for his 1 year and 3 months-old black-breasted Game Cock, and 2 years 2 months-old black-breasted Game Hens; bred by himself.

*Henry Marshall, of Cotgrave, near Nottingham: for his 2 years and 2 months-old black-breasted red Game Cock and two Hens; bred by himself.

*Rev. Thomas Lyon Fellowes: for his 1 year and 4 months-old brown-breasted red Game Cock and two Hens; bred by himself.

*Cornelius Giles, of Warminster: for his 1 year 1 month 2 weeks and 4 days-old black-and-red Game Cock and two Hens; bred by J. Muspratt, of Heytesbury.

*Captain Hornby, R.N., of Knowsley Cottage: for his (above) 1 year-old red Game Cock; bred by himself.

*Thomas Porter, of Baunton: for his (about) 2 years and 2 or 3 months-old black-breasted red Game Cock; bred by Nathan Dyer, of Bredon, Tewkesbury.

*John Keable, of Thatcham, near Newbury: for his 3 years 2 months and 5 days-old black-breasted red Game Cock; bred by S. Trevoir Dickens, of Stoke-by-Mayland. Colchester.

*Henry Marshall, of Cotgrave: for his 3 years 1 month and 2 weeks-old black-breasted red Game Cock; bred by William Mellows, of Carburton, Mansfield.

*George Botham, of Wexham Court: for his 1 year and 1 month-old golden-pencilled Hamburg Cock and two Hens; the Cock bred by J. Jeffrey, of Hedgerley, Bucks, and the Hens by the Exhibitor.

*George Caleb Adkins, of West House: for his 1 year and 2 months-old golden-pencilled Hamburg Cock and two Hens; breeder stated to be unknown.

*Thomas Parker Mew, of West-Cowes, Isle of Wight: for his (about) 1 year and 4 months-old golden-pencilled Hamburg Cock and two Hens; bred by himself.

*James Howard, of St. John, Bedford: for his 2 years and 3 months-old golden-pencilled Hamburg Cock and two Hens; bred by himself and J. Worrall, of Liverpool.

*George Godfrey, of Aylesbury: for his 7 weeks-old dark-coloured Rouen Drake and two Ducks; bred by John Weston, of Aylesbury.

*John Weston, of Aylesbury: for his 3 months-old dark-coloured Rouen Drake, and his 2 months-old dark-coloured Rouen Ducks; bred by himself.

*John Weston: for his 8 weeks-old dark-coloured Rouen Drake and two Ducks; bred by himself.

*John Weston: for his 7 weeks-old dark-coloured Rouen Drake and two Ducks; bred by himself.

*Henry Fookes, of Whitechurch: for his 13 weeks-old brown Rouen Drake and two Ducks; bred by himself.

*James Marriott, of Floore, Weedon: for his (about) 3 years-old Rouen Drake and two Ducks; bred by George Bothan, of Wexham Court.

*Charles Ballance, of Taunton: for his 1 year and 4 months-old wild-duck coloured Rouen Drake and two Ducks; bred by himself.

†Robert Loder, of The High Beeches: for his 2 years 1 month and 3 weeks-old grey Dorking Cock; bred by himself.

†George Botham, of Wexham Court: for his 3 years-old Dorking Cock; bred by John Baily, of Mount Street.

†William Fisher Hobbs, of Boxted Lodge: for his 2 years and 2 months-old grey Dorking Cock; bred by himself.

†William Fisher Hobbs: for his 1 year and 2 months-old grey Dorking Cock; bred by himself.

†Rev. John Leyborne Popham, of Chilton Rectory: for his 2 years and 3 months-old dark-speckled Dorking Cock; bred by himself.

†John Fill Hart, of Fisherton-de-la-Mere, Heytesbury: for his 2 years and 3 months-old copper-coloured Turkey Cock and two Hens; bred by himself.

†John Fill Hart: for his 1 year and 3 months-old brown Turkey Cock and two Hens; bred by himself.

†John Weston, of Aylesbury: for his 2 months-old white Aylesbury Drake and two Ducks; bred by himself.

†John Weston: for his 9 weeks-old white Aylesbury Drake and two Ducks; bred by himself.

†John Weston: for his 2 months and 2 weeks-old white Aylesbury Drake and two Ducks; bred by himself.

IMPLEMENTS.

Richard Hornsby and Son, of Spittlegate, Grantham: the Prize of Five Sovereigns, for their Drilling-Machine for corn and seeds, and for general purposes; invented, improved, and manufactured by themselves.

Richard Garrett and Sons, of Leiston Works, Saxmundham: the Prize of Three Sovereigns, for their Combined General-Purpose Drill and Broadcast Manure-Distributor; invented by Thomas Chambers, jun., and the Exhibitors, and improved and manufactured by the Exhibitors.

Holmes and Sons, of Prospect-Place Works, Norwich: the Prize of Seven Sovereigns, for their Corn and Seed Drill, for large occupations; invented, improved, and manufactured by themselves.

Richard Hornsby and Son, of Spittlegate: the Prize of Two Sovereigns, for their Small-Occupation Drill; invented, improved, and manufactured by themselves.

Richard Garrett and Sons, of Leiston Works: the Prize of Two Sovereigns, for their Exeter-Prize Lever Corn and Seed Drill, for small occupations; invented, improved, and manufactured by themselves.

Richard Hornsby and Son, of Spittlegate: the Prize of Five Sovereigns, for their Two-row Ridge Drill for turnips, mangold-wurzel, and manure; invented, improved, and manufactured by themselves.

Richard Garrett and Sons, of Leiston Works: the Prize of Two Sovereigns, for their Drill for seed and manures on the ridge; invented and manufactured by themselves.

Richard Garrett and Sons: the Prize of Four Sovereigns, for their Combined Seed and Liquid Manure Drop-Drill; invented by W. C. Spooner, of Eling, near Southampton, and T. Chambers, of Colkirk Hall, Fakenham; and improved and manufactured by the Exhibitors.

Richard Garrett and Sons: the Prize of Eight Sovereigns, for their Chambers's Broadcast Manure-Distributor; invented by T. Chambers, of Colkirk Hall, and improved and manufactured by the Exhibitors.

Holmes and Sons, of Prospect-Place Works: the Prize of Five Sovereigns, for their Dry-Manure Distributor; invented, improved, and manufactured by themselves.

Robert and John Reeves, of Bratton, near Westbury: the Prize of Five Sovereigns, for their Dry-Manure Distributor; invented and manufactured by themselves.

Isaac James, of Tivoli, Cheltenham: the Prize of Two Sovereigns, for his 270-gallons Liquid-Manure Distributor; invented and manufactured by himself.

Richard Garrett and Sons, of Leiston Works: the Prize of Three Sovereigns, for their Horse-Hoe, adapted for every variety of drilled root or grain crop, for every description of soil, and for hilly land; invented, improved, and manufactured by themselves.

William Smith, of Kettering: the Prize of Two Sovereigns, for his Steerage Horse-Hoe, with double-bar; invented, improved, and manufactured by himself.

Hugh Carson, of Warminster: the Prize of One Sovereign and a half, for his Wrought-Iron Horse-Hoe and Scuffling Plough; invented, improved, and manufactured by himself.

Priest and Woolnough, of Kingston-on-Thames: the Prize of Two Sovereigns, for their Horse-Hoe; invented, improved, and manufactured by themselves.

Edward Hammond Bentall, of Heybridge, near Maldon: the Prize of One Sovereign and a half, for his Double-Ridge Hoe (marked M H C), or one of his Broad-Shares on a small scale, adapted for hoeing two ridges at once; invented and manufactured by himself.

Burgess and Key, Newgate-Street, London: the Prize of Ten Sovereigns, for their Reaping-Machine; invented by C. H. MacCormick, of Chicago, United States of America; and improved and manufactured by themselves.

Alfred Crosskill, of Beverley, Yorkshire: the Prize of Six Sovereigns, for his Reaping-Machine; manufactured by himself.

Lord Kinnaird, of Rossie Priory, Inchture, Perthshire: the Prize of Four Sovereigns, for his Reaping-Machine; invented by C. MacCormick, of the United States of America; improved by the Exhibitor, and manufactured by James Burry, of Knap Works, Inchture.

Henry Clayton, of Atlas Works, Upper Park-Place, Dorset-Square, London: the Prize of Fifteen Sovereigns, for his Eagle Reaping and Mowing Machine, with automatic delivery; invented by J. H. Caryl, of Sandusky, Ohio, and manufactured by Nurse, Mason, and Co., of Boston, Massachusetts, United States of America.

William Dray and Co., of Swan-Lane, London: the Prize of Five Sovereigns, for their Mowing Machine; invented by J. Catchcome, of the United States of America; improved and manufactured by the Exhibitors.

William Newzam Nicholson, of Newark-on-Trent: the Prize of Four Sovereigns, for his One-Horse Haymaking Machine; invented, improved, and manufactured by himself.

Barrett, Exall, and Andrewes, of Katesgrove Iron Works, Reading: the Prize of Three Sovereigns, for their Double-Action Haymaking Machine; invented, improved, and manufactured by themselves.

Smith and Ashby, of Stamford: the Prize of Two Sovereigns, for their Double-Action and Reverse-Motion Haymaking Machine; invented, improved and manufactured by themselves.

Henry Atwood Thompson, of Lewes: the Prize of One Sovereign, for his

Reverse-Action Haymaking Machine; invented, improved, and manufactured by himself.

James and Frederick Howard, of Britannia Iron Works, Bedford: the Prize of Three Sovereigns, for their Horse-Rake, intended for hay, corn, stubbles, or couch-grass, and for raking-in clover seeds in the spring; invented and manufactured by themselves.

Ransomes and Sims, of Ipswich: the Prize of Three Sovereigns, for their Iron Suffolk Horse-Drag Rake; invented, improved, and manufactured by themselves.

Barnabas Urry, of Vectis Works, Newport, Isle of Wight; the Prize of Two Sovereigns, for his Tooth-Action Horse-Rake; improved and manufactured by himself.

Smith and Ashby, of Stamford: the Prize of One Sovereign, for their Steel-tooth Horse-Rake, for hay, corn, stubble, couch-grass, &c.; invented, improved, and manufactured by themselves.

William Langford Fisher, of Thrapston, Northamptonshire: the Prize of One Sovereign, for his Wrought-iron-bar Horse-Rake; invented and improved by Nathaniel Smith, of Thrapston, and manufactured by the Exhibitor.

Thomas Milford and Son, of Thorverton, near Collumpton, Devonshire: the Prize of Two Sovereigns, for their Prize Two-Horse Waggon; invented, improved, and manufactured by themselves.

John Kiddle, of Donhead St. Mary, near Salisbury: the Prize of Two Sovereigns, for his Light Two-Horse Waggon; invented and manufactured by himself.

Alfred Crosskill, of Beverley: the Prize of Two Sovereigns, for his Pair-Horse Waggon; invented and improved by William Crosskill, and manufactured by the Exhibitor.

John Gifford, of Horsington, near Wincanton: the Prize of Two Sovereigns, for his Farm and General-Purpose Waggon; manufactured by himself.

Isaac James, of Tivoli, Cheltenham: the Prize of One Sovereign, for his Strong, Light, Two-or-three-Horse Waggon, for agricultural and road purposes; improved and manufactured by himself.

George Milford, of Thorverton, near Collumpton: the Prize of One Sovereign, for his Strong and Light Two-Horse Waggon: invented, improved, and manufactured by himself.

William Busby, of Newton-le-Willows, near Bedale: the Prize of Two Sovereigns, for his Strong and Light Draught-axle One or Two Horse Cart; invented by J. Scott, of Brown Close, Yorkshire, and improved and manufactured by the Exhibitor.

William Ball, of Rothwell, near Kettering: the Prize of Two Sovereigns, for his Light One-Horse Cart; invented, improved and manufactured by himself.

Thomas Milford and Son, of Thorverton: the Prize of Two Sovereigns, for his One-Horse Cart, for general farm, road, and harvest purposes; invented, improved, and manufactured by themselves.

James Woods, of the Suffolk Iron Works, Stowmarket: the Prize of Two Sovereigns, for his One-Horse Cart with jointed Harvest-Frame; invented, improved, and manufactured by himself.

Alfred Crosskill, of Beverley: the Prize of One Sovereign, for his Newcastle or Model One-Horse Cart, for ordinary farm and harvest work; invented and improved by William Crosskill, and manufactured by the Exhibitor.

James and Frederick Howard, of Bedford: the Prize of One Sovereign, for their Bedfordshire One-Horse Cart, for harvest and manure purposes; improved by, and manufactured for, the Exhibitors.

THOMAS MILFORD and SONS, of Thorverton: the Prize of FOUR SOVEREIGNS, for their Cranked-axle One-Horse Cart for general purposes; invented and manufactured by themselves.

WILLIAM BUSBY, of Newton-le-Willows: the Prize of FOUR SOVEREIGNS, for his One or Two Horse low-bodied and low-shafted Cart; invented by William Lister, of Dunsa Bank, and improved and manufactured by the Exhibitor.

ALBERT and THEODORE FRY, of Bristol: the Prize of THREE SOVEREIGNS, for their General-Purpose Crank-axle Farm-Cart, for the easy loading and unloading of every description of farm-produce; invented, improved, and manufactured by themselves.

ALFRED CROSSKILL, of Beverley: the Prize of TWO SOVEREIGNS, for his Cranked-axle Cart; invented, improved, and manufactured by himself.

JAMES and FREDERICK HOWARD, of Bedford: the Prize of TWO SOVEREIGNS, for their Cranked-axle One-Horse Cart; improved by, and manufactured for, themselves.

MEDALS.

ROBERT and JOHN REEVES, of Bratton, near Westbury: a SILVER MEDAL, for their Economical Dry-Manure and Seed Drill, for drilling artificial manure in its pure state without admixture with ashes; invented and manufactured by themselves.

JAMES and FREDERICK HOWARD, of Bedford: a SILVER MEDAL, for their Drill-Presser, intended to follow three ploughs, and, in addition to pressing the furrows, to deposit and cover the seed at one operation; improved and manufactured by themselves.

THOMAS MILFORD and SON, of Thorverton: a SILVER MEDAL, for their Model One-Horse Cart, for general farm, road, and harvest purposes, in which the shafts are attached in such a manner as to attain a straight line of draught from the axle; invented by Frank P. Milford, of Thorverton, and manufactured by the Exhibitors.

THOMAS PAIN, of Laverstock Hall, near Salisbury: a SILVER MEDAL, for his Iron Turf-paring Plough, intended to supersede the old Breast-plough, and to cut and turn up turf to any thickness; invented by himself, and manufactured by Brown and May, of Devizes.

SAMUEL ROWSELL, of Buckland St. Mary, near Chard: a SILVER MEDAL, for his American Iron-pointed Horse-Rake, for collecting hay, raking corn, or gathering stubble; invented, improved, and manufactured by himself.

COTTAM and COTTAM, of St. Pancras Iron Works, Old St. Pancras Road, London: a SILVER MEDAL, for their set of Collar-bar Sheep Hurdles, in which the collars are welded on the horizontal bars, and threaded alternately through the upright bars in such a manner, that the centre-upright is retained in its position, while the bars, being confined at short bearings, and acting as tension-rods, acquire double strength; invented and manufactured by themselves.

PERREAUX and Co., 39, Mark-Lane, London: a SILVER MEDAL, for their Two-and-half-inch vulcanised India-Rubber Pump-Valve, which takes the form of a tube flattened at one extremity similar to the mouth-piece of a hautbois, and the thickness of the sides or walls diminishes gradually to the top, where the two sides meet and form two lips, which being flexible and elastic open and close on the slightest pressure, and allow any foreign substance in the fluid to pass through them without interfering with or deranging the action of the valves; invented by Louis Guillaume Perreaux, of Paris, and manufactured by the Exhibitors.

HILL and SMITH, of Brierley Hill Iron Works, Dudley: a SILVER MEDAL, for their Wrought-iron Sheep-trough, on four wheels, constructed to prevent its being upset, or the sheep jumping over it or throwing out their food; invented, improved, and manufactured by themselves.

HUGH CARSON, of Warminster: a SILVER MEDAL, for their Single Cheese-Press, with double lever and pulley, by which the simple weight is doubled, and great pressure obtained for large cheeses; invented, improved, and manufactured by himself.

EDWARD COCKEY and SONS, of Frome-Selwood, Somersetshire: a SILVER MEDAL, for their Cheese-making Apparatus; consisting of an improved heating boiler, enclosed in an iron case lined with fire-brick; a strong tin-plated cheese-tub of 120 gallons capacity, with a hollow copper chamber beneath its bottom for hot and cold water; as well as iron-pipes (with cocks for regulating the flow of water) connecting the boiler and tub, and so arranged as to provide means for heating the air of the cheese-room from the same boiler: invented and manufactured by themselves.

E. A. FERRYMAN, of Eastry Vicarage, Sandwich, Kent: a SILVER MEDAL, for his Self-Kneading Lever-Churn; invented by himself and manufactured by J. Gann, of Oundle.

RICHARD COLEMAN, of Chelmsford: a SILVER MEDAL, for his Two-Horse Potato-Digger, adapted for taking up drilled root-crops, by means of shares passing underneath the roots or tubers, while forks revolving at the same time throw them up to the surface; invented by John Hanson, of Doagh, and improved and manufactured by the Exhibitor.

Commendations.

The mark * signifies "HIGHLY COMMENDED;" and the mark † "COMMENDED."

RICHARD HORNSBY and SON, of Spittlegate, Grantham: for their Ten-row Corn and Seed Drill, with India-rubber tubes for depositing corn or seed on level or hilly ground; invented, improved, and manufactured by themselves.

*RICHARD GARRETT and SONS, of Leiston Works, Saxmundham: for their Suffolk Lever Corn and Seed-Drill, adapted for drilling all kinds of grain and seeds in rows at any distance apart, and fitted with fore-carriage steerage; improved and manufactured by themselves.

*RICHARD HORNSBY and SON: for their Twelve-row Corn-Drill, very similar to the Ten-row drill above described; invented, improved, and manufactured by themselves.

*HOLMES and SONS, of Norwich: for their Manure and Seed-Drill, for flat or ridged work, having rollers for ridges, concave rollers for covering manure, and flat-rollers for covering seed, as well as an arrangement by which any required quantity of water may be delivered with the dry manure; invented, improved, and manufactured by themselves.

*ROBERT and JOHN REEVES, of Bratton, Westbury: for their Four-row Liquid and Seed-Drill, for flat work, capable of drilling any kind of thick manure from cattle-sheds, &c., or mixing any kind of artificial manure with water; invented by Thomas Chandler, of Aldbourn, near Hungerford, and improved and manufactured by the Exhibitors.

*HENRY COGAN of Trent, near Sherborne, for his light and strong convertible Cultivator, to be used, with one, two, three, or four horses, as a horse-hoe, broadshare-cultivator, scarifier, drag-harrow, or couch-rake; invented and manufactured by himself.

*JAMES and FREDERICK HOWARD, of Bedford: for their Horse-Hoe, intended for one row of turnips, beans, &c., and for three rows of wheat, with sliding shares, stirring-grubbers, and cleansing harrows; invented and manufactured by themselves.

*JONATHAN STALKER, of Penrith: for his Wrought-iron Horse-Hoe or Stetch

Grubber, with expanding screws to regulate its width and depth; invented, improved, and manufactured by himself.

*HOLMES and SONS, of Norwich: for their one-horse three-row Steerage Horse-Hoe, for flat and ridged work, with sliding axles and shifting shafts on the quarter; invented and manufactured by themselves.

*WILLIAM BUSBY, of Newton-le-Willows: for his Horse-Hoe, with three tines and revolving harrow, for flat and ridged work; invented, improved, and manufactured by himself.

*RANSOMES and SIMS, of Ipswich: for their Wrought-iron Horse-Hoe for ridged work, with harrows attached, having a triangular hoe in front and curved cutter on each side, and being easily adjusted to the required width; invented, improved, and manufactured by themselves.

*MAPPLEBECK and LOWE, of Birmingham: for their Expanding Horse-Hoe, with one wheel, a set of hoes, and a set of grubber-tines; improved and manufactured by themselves.

*BURGESS and KEY, of Newgate-Street, London: for their Reaping-Machine; invented by C. H. M'Cormick, of Chicago, and improved and manufactured by themselves.

*WILLIAM DRAY and Co., of Swan-Lane, London: for their Reaping-Machine; invented by John Palmer, of Stockton; improved (and now provided with a side-delivery) and manufactured by the Exhibitors.

*WILLIAM NEWZAM NICHOLSON, of Newark-on-Trent: for his Haymaking Machine, fitted with double tubular-iron shafts, for two horses abreast, with annular gearing for backward motion, improved arrangement to prevent the coiling or clogging of the hay, and four sets of fork-heads; invented, improved, and manufactured by himself.

*WILLIAM WILLIAMS, of Bedford: for his Lever Horse-Rake, having a square bar running through the heads of the teeth, by which they are raised; invented, improved, and manufactured by himself.

*JOHN COOPER and Co., of Ipswich: for their Self-acting Counter-balance Lever Horse-Rake, adapted for hay, corn, twitch, or grass-stubble; the teeth having each its own counter-balance, adjusting themselves more readily on that account to the uneven surface of the land; lightness of draught and freedom from collection of soil with the corn being thus attained; while a lad can lift and clear the leverage with stopping the horse: invented by Thomas Smith, of Bradfield, and manufactured by the Exhibitors.

*JOSEPH MARYCHURCH and SON, of Haverfordwest: for their Self-acting Horse-Rake, without springs or cog-wheels, the teeth being relieved of their load by the motion of the horse, and may be managed by one lad, walking before, behind, or at the side of the rake, without his treading upon the raked hay; invented and improved by William Marychurch, and manufactured by the Exhibitors.

*GEORGE MILFORD, of Thorverton: for his light and strong Two-horse Waggon, capable of carrying 50 cwt.; invented, improved, and manufactured by himself.

*ALFRED CROSSKILL, of Beverley: for his light and strong Pair-horse Waggon, with break which the driver can put in action by turning a handle as he walks alongside the horses; invented and improved by William Crosskill, and manufactured by the Exhibitor.

*WILLIAM DRAY and Co., of Swan-Lane, London: for their light Two-horse Waggon, adapted for farm, road, and harvest purposes; invented, improved, and manufactured by themselves.

*WILLIAM DRAY and Co.: for their Light Van, with pole and shafts, and light waterproof covering; invented, improved, and manufactured by themselves.

*ARTHUR SILCOCK, of Chippenham: for his light and strong One-horse Cart, of oak framework, for general agricultural purposes, with tipping apparatus; invented and manufactured by himself.

*GEORGE MILFORD, of Thorverton: for his strong and durable One-horse Cart, with tipping apparatus, invented by George Milford, jun., the cart adapted for being well balanced on the horse, elevated for throwing out manure in different heaps, and its weight lessened on the horse when descending steep hills; invented, improved, and manufactured by the Exhibitor.

*Henry Atwood Thompson, of Lewes: for his strongly-constructed One-horse Model-Cart, adapted for all purposes, and to carry 30 cwt., and fitted with spring tipper and grease-chambers; invented, improved, and manufactured by himself.

*Hayes and Son, of Stamford: for their oak-framed One-horse Scotch Cart, with tipping apparatus, and intended to suit all requirements of farm and road-work; invented, improved, and manufactured by themselves.

*William Crowley and Sons, of Newport-Pagnell: for their light One-horse Newport Cart for general purposes, with tipping apparatus and harvest-ladders, complete, and capable of carrying 1½ ton; invented, improved, and manufactured by themselves.

*Albert and Theodore Fry, of Bristol: for their simply-constructed Newport Cart, fitted with commodious harvesting ladders, and adapted for exportation to the Colonies; invented, improved, and manufactured by themselves.

*William Brown and Charles N. May, of Devizes: for their One-horse Cart, simple, strong, plain, and useful, adapted for ordinary farm-work, and capable of carrying 30 cwt.; improved and manufactured by themselves.

*Samuel Garn, of Sevenhampton, near Highworth, Wiltshire: for his light and strong One-horse Cart, for general purposes, with tipping apparatus; invented and manufactured by himself.

*John Eaton, of Twywell Works, Thrapston: for his One-horse Cart with harvest eaves complete, tipping apparatus, and self-acting tail-board, intended for general farm purposes; improved and manufactured by himself.

*Bernhard Samuelson, of Banbury: for his Turnip-Thinner, adapted for thinning out turnips and other green crops on the flat or ridge, at any required distance, and constructed so as to be easily raised up where the plants do not require thinning; invented by Thomas Huckvale, of Choice Hill, and manufactured by the Exhibitor.

*Burgess and Key, of Newgate-Street, London: for their American Platform-Beehive, adapted for ventilating the series of hives employed, for transferring the bees as often as required, for feeding them during winter and spring, and for removing the filth without disturbing them, while the honey made is of superior quality, and the bees may be seen at work in the hives; invented by Silvester Davis, of Caremont, in the United States of America, and manufactured by the Exhibitors.

*Edward Weir, of 16, Bath-place, New Road, London: for an American Floating-Ball Washing-Machine, capable of washing six shirts, or an equal quantity of linen, in five minutes; invented by Hollingsworth, of Indiana, in the United States of America, and manufactured by B. Moore and Co., of 133, High Holborn, London.

*Philip Johnston, of 292, Oxford-Street, London: for his Assortment of Churns.

*Thomas Richards, of Wincanton: for his series of Circular-fronted Cooking Ranges; invented and improved by himself, and manufactured by the Coalbrookdale Company, Shropshire.

*John James, of 115, Leadenhall-Street, London: for his One-hundredweight Weighing-Machine, or simple modification of a steelyard, fitted to a strong vertical support, with scoop-scale attached for weighing potatoes and other root-crops, or coals, &c.; invented and manufactured by James and Malcolm.

*Burgess and Key, of Newgate-Street, London: for their Force-and-Lift Pump, or Farm Fire-Engine, with iron barrels, ordinary plungers, and brass inlet and outlet; invented by Kase, of America, improved and manufactured by the Exhibitors.

*Cottam and Hallen, of Winsley-Street, Oxford-Street, London: for their assortment of Stable-Fittings; improved and manufactured by themselves.

*James and Frederick Howard, of Britannia Iron Works, Bedford: for their Set of Iron tubular Whipple-trees, intended for a four-horse team, all drawing from the same common middle-chain passed round a pulley on the head of the plough, or other implement; invented by the Marquis of Tweeddale, and improved and manufactured by the Exhibitors.

*Greening and Co., of the Victoria Iron Works, Oxford-Street, Manchester: for

their strong and tenacious jet-varnished iron-wire Sheepfold Fence (marked No. 7 B); manufactured by themselves.

*WILLIAM PROCKTER STANLEY, of Peterborough: for his Hand Sack-Barrow and Sack-Raiser, intended to be used with steam-thrashing machines, and stated to save the labour of one man a-day; invented, improved, and manufactured by himself.

*BARNARD and BISHOP, of Norwich: for their Cast-iron Water-Cock, for water-butts and tanks; improved and manufactured by Gidney and Son, of Dereham.

*JOSEPH GRIPPER, of Colchester: for his Wrought-iron Sheep or Cattle Trough, on wheels, easily moved by a boy from place to place when filled with 35 gallons of water, and not liable to be turned over or broken; invented, improved, and manufactured by himself.

*THOMAS GIBBS and Co. (seedsman to the Royal Agricultural Society of England, corner of Halfmoon-Street, Piccadilly, London: for their Collection of Seeds and Roots.

†HOLMES and SONS, of Norwich: for their Corn and General-Purpose Drill; invented, improved, and manufactured by themselves.

†HOLMES and SONS: for their Corn and Seed Drill for smaller occupations; invented, improved, and manufactured by themselves.

†JOHN GREEN, of Saffron-Walden: for his Horse-Hoe; invented, improved, and manufactured by himself.

†ALBERT and THEODORE FRY, of Bristol: for their iron Horse-Hoe for green crops, especially adapted to work horizontally on hill-sides; invented by R. Cosens, of Pilton, and improved and manufactured by the Exhibitors.

†WILLIAM DRAY and Co., of Swan-Lane, London: for their Reaping-Machine; invented by Obed Hussey, of the United States of America, and improved and manufactured by the Exhibitors.

†ROBERT LANE, of Cirencester: for his One-horse Cart for agricultural purposes, capable of being tipped before or behind to any elevation, the wheels being high and the body low; improved and manufactured by himself.

†JOHN KENDELL, of Cashmoor, near Blandford: for his Two-horse broad and low Gloucestershire Waggon, adapted for road and harvest purposes; improved and manufactured by himself.

†RICHARD READ, of Regent Circus, Piccadilly, London: for his Stand of Hydraulic and other apparatus, namely, Fire and Watering Engines, Garden Pumps, Syringes and Tobacco-fumigators, and Choke-probangs and Injecting-instruments for cattle and horses; improved and manufactured by himself.

†CHARLES POWELL, of Ticehurst, near Hurstgreen: for his Four-row Depositor Hand Bean-Dibble; manufactured by himself.

†COTTAM and COTTAM, of Old St. Pancras Road, London: for their full-sized Model of a Stall, fitted up to show the swing-manger; invented by Professor Varnell, of the Royal Veterinary College, London, and manufactured by the Exhibitors.

†JAMES WOODS, of Stowmarket: for his Asphalting Apparatus, for laying down asphalt flooring, paths, &c.; invented, improved, and manufactured by himself.

†WILLIAM BUSBY, of Newton-le-Willows: for his Implement for topping and tailing turnips; invented by William Lister, of Dunsa Bank, and improved and manufactured by the Exhibitor.

†HILL and SMITH, of Brierley, near Dudley: for their Selection of Premium Iron Hurdles, made of the best Staffordshire wrought-iron, by machinery, in a cold state; invented and manufactured by themselves.

†ARTHUR LYON, of Windmill-Street, Finsbury, London: for his Machine for cutting or mincing meat, fish, &c., as well as for cutting sausage-meat, and at the same time filling the sausage skins; invented, improved, and manufactured by himself.

†BENJAMIN FOWLER, of Whitefriars-Street, London: for the Valve-Box in a Double-barrel portable Force and Irrigating Pump for farm purposes; invented by Stephen Holman, of Deptford, and improved and manufactured by B. Fowler and Co.

†WALLIS and HASLAM, of Basingstoke; for their Machine for drilling iron by

hand or other power, capable of being easily worked by a boy, and intended for manufacturers, for gentlemen who have work done on their own estates; invented, improved, and manufactured by the Exhibitors.

†Burgess and Key, of Newgate-Street, London: for an American Rotary One-horse-power, adapted for working chaff-engines and mills, and for pumping water, &c.; improved and manufactured by Isaac Hartas, of Wrelton, near Pickering.

†James and Frederick Howard, of Bedford: for their Oval-Iron Plough-Coulter, invented and manufactured by themselves.

†William Crowley and Sons, of Newport-Pagnell: for their Set of Newport Hames, for general purposes; invented, improved, and manufactured by themselves.

†Henry Atwood Thompson, of Lewes: for his Workman's Bevel for laying drain-pipes; invented and manufactured by himself.

†Peter Lawson and Son, of Edinburgh and London: for their Collection of Seeds.

†Thomas Bigg, of Great Dover-Street, Southwark: for the cradle in his moveable Sheep-Dipping Apparatus, on wheels, in which the sheep is placed, and thus prevented from struggling, and its back from coming into contact with any deposit of composition in the tub; invented, improved, and manufactured by himself.

†Burney and Bellamy, of Mill-Wall, London: for their Wrought-iron Cattle-Trough; invented and manufactured themselves.

†Edwin Allan Athawes, of 63, Blackfriars-Road, London: for his cast-steel Percolator-Fork, with central tine longer and more advanced than the lateral ones, and of peculiar leverage, for the purpose of penetrating and loosening the soil, and of promoting through it deep down to the roots of growing crops the circulation of air and moisture; invented by himself, and manufactured by Parkes and Co., of Birmingham.

†Charles Powell, of Ticehurst: for a Set of Three Steel Draw-Shave Hoes, by which, it is stated, one man can hoe upwards of an acre in a day; manufactured by himself.

†Ransomes and Sims, of Ipswich: for a Set of Stable-Fittings, by which any place enclosed by four falls and a roof may, in a few minutes, and without mechanical aid, be converted into a convenient loose-box; invented by J. A. Bruce, of Gwyrch Castle, Ireland; improved and manufactured by the Exhibitors.

James Hudson,
Secretary.

London, August, 1857.

Essays and Reports.—PRIZES FOR 1858.—All Prizes of the Royal Agricultural Society of England are open to general competition. Competitors will be expected to consider and discuss the heads enumerated.

I. MICROSCOPIC INVESTIGATION.

Fifty Sovereigns will be given for the best Report on the Results of Microscopic Observation applied to the Vegetable Physiology of Agriculture.

It is not thought desirable to confine the observer too strictly to any particular line of research, the only necessary limitation being, that the plants to be examined and reported upon shall be selected from those commonly cultivated; such as the *cereals*, or those usually known under the names of *pulse*, *root*, and *fodder* crops. The structural formation of these plants—their ordinary vital processes—modifications of the above induced by climatic influences or the application of manure—morbid changes of their tissues consequent upon the attacks of insects or disease,—would all prove extensive and interesting fields of inquiry; and it must be left to the writers themselves to select those particular branches of the subject on which they are able to supply the greatest amount of original information.

II. FARMING OF SHROPSHIRE.

Fifty Sovereigns will be given by the Society for the best Account of the Farming of Shropshire.

Describing the physical features of the County, its Rivers, Geological Sections, and peculiarities of Agricultural Practice on Light and Heavy Soils respectively; Drainage, Irrigation, Farms of particular note; principal Markets; recent Changes of Population; character of Live Stock; notice of former Agricultural Reports of the County; Improvements since Kennedy and Granger's Survey for the Board of Agriculture; Changes in progress, or still needed.

III. THE CHANNEL ISLANDS.

Twenty-five Sovereigns will be given for the best Report on the Agriculture of the Islands of Jersey, Guernsey, Alderney, and Sark.

The leading physical features of each should be given: character of the Soil; its Agricultural Tenures; size of Farms, as well as various modes of cultivation, describing any peculiarities of local practice; Implements; Live Stock; Dairy Management; Imports and Exports of Farming Produce; Population; reference to former Agricultural Surveys, or notices of a like character; Agricultural changes in progress, or needed.

IV. DRILLING CORN AT DIFFERENT WIDTHS.

Ten Sovereigns will be given for the best Report on the result of drilling wheat at different widths with the same quantities of seed, and also with different quantities of seed per acre.

The following set of experiments is recommended, but competitors will be at liberty to adopt any other which will furnish the information required. The trial plots must not contain less than half an acre each :—

Plots 1, 2, 3, drilled at 12 inches from row to row with 4, 6, and 8 pecks of seed per acre, respectively.

Plots 4 and 5, at 10 inches from row to row, with 6 and 8 pecks respectively.

Plots 6 and 7, at 8 inches from row to row, with 6 and 8 pecks respectively.

V. MANAGEMENT OF BREEDING CATTLE.

Twenty Sovereigns will be given for the best Essay on the Management of a Herd of Breeding Cattle, with especial reference to the kind of diet, the treatment, and the condition best calculated to ensure regular fecundity and successful gestation; and on the causes which operate adversely in particular seasons.

VI. MANURING GRASS LAND.

Twenty Sovereigns will be given for the best Report on the Improvement of Grass Land by the use of different manures or manurial substances. Quantities and cost must be stated, as well as the time and mode of application.

VII. LARGE AND SMALL FARMS.

Twenty Sovereigns will be given for the best Essay on the Comparative Advantages of Large and Small Farms, whether adapted for Dairy, Arable, or Grazing purposes.

VIII. ANY OTHER AGRICULTURAL SUBJECT.

Ten Sovereigns will be given for the best Essay on any other agricultural subject.

Reports or Essays competing for the Prizes must be sent to the Secretary of the Society, at 12, *Hanover Square, London, on or before March* 1, 1858. *Contributors of Papers are requested to retain Copies of their Communications, as the Society cannot be responsible for their return.*

Rules, &c.

RULES OF COMPETITION FOR PRIZE ESSAYS.

1. All information contained in Prize Essays shall be founded on experience or observation, and not on simple reference to books or other sources. Competitors are requested to use foolscap or large letter paper, and not to write on both sides of the leaf.

2. Drawings, specimens, or models, drawn or constructed to a stated scale, shall accompany writings requiring them.

3. All competitors shall enclose their names and addresses in a sealed cover, on which only their motto, the subject of their Essay, and the number of that subject in the Prize List of the Society, shall be written.*

4. The President or Chairman of the Council for the time being shall open the cover on which the motto designating the Essay to which the Prize has been awarded is written, and shall declare the name of the author.

5. The Chairman of the Journal Committee shall alone be empowered to open the motto-paper of any Essay not obtaining the Prize, that he may think likely to be useful for the Society's objects; with a view of consulting the writer confidentially as to his willingness to place such Essay at the disposal of the Journal Committee.

6. The copyright of all Essays gaining Prizes shall belong to the Society, who shall accordingly have the power to publish the whole or any part of such Essays; and the other Essays will be returned on the application of the writers; but the Society do not make themselves responsible for their loss.

7. The Society are not bound to award a prize unless they consider one of the Essays deserving of it.

8. In all reports of experiments the expenses shall be accurately detailed.

9. The imperial weights and measures only are those by which calculations are to be made.

10. No prize shall be given for any Essay which has been already in print.

11. Prizes may be taken in money or plate, at the option of the successful candidate.

12. All Essays must be addressed to the Secretary, at the house of the Society.

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* **Competitors are requested to write their motto on the enclosed paper on which their names are written, as well as on the outside of the envelope.**

Members' Privileges of Chemical Analysis.

The Council have fixed the following rates of Charge for Analyses to be made by the Consulting Chemist for Members of the Society; who, to avoid all unnecessary correspondence, are particularly requested, when applying to him, to mention the kind of analysis they require, and to quote its number in the subjoined schedule. The charge for analysis, together with the carriage of the specimens, must be paid to him by members at the time of their application.

No. 1.—An opinion of the genuineness of Peruvian guano ..	5s.
,, 2.—An analysis of guano; showing the proportion of moisture, organic matter, sand, phosphate of lime, alkaline salts, and ammonia	10s.
,, 3.—An estimate of the value (relatively to the average of samples in the market) of sulphate and muriate of ammonia, and of the nitrates of potash and soda	10s.
,, 4.—An analysis of superphosphate of lime for soluble phosphates only	10s.
,, 5.—An analysis of superphosphate of lime, showing the proportions of moisture, organic matter, sand, soluble and insoluble phosphates, sulphate of lime, and ammonia	£1.
,, 6.—An analysis (sufficient for the determination of its agricultural value) of any ordinary artificial manure	£1.
,, 7.—Limestone:—the proportion of lime, 7s. 6d.; the proportion of magnesia, 10s.; the proportion of lime and magnesia	15s.
,, 8.—Limestones or marls, including carbonate, phosphate, and sulphate of lime, and magnesia with sand and clay	£1.
,, 9.—Partial analysis of a soil, including determinations of clay, sand, organic matter, and carbonate of lime ..	£1.
,, 10.—Complete analysis of a soil	£3.
,, 11.—An analysis of oil-cake, showing the proportion of moisture, oil, mineral matter, albuminous matter, and woody fibre; as well as of starch, gum, and sugar, in the aggregate	£1.
,, 12.—Analyses of animal products, refuse substances used for manure, &c. .. .. .. from 10s. to	30s.
,, 13.—Determination of the "hardness" of a sample of water before and after boiling	10s.
,, 14.—Analysis of water of land drainage, and of water used for irrigation	£2.
,, 15.—Determination of nitric acid in a sample of water ..	£1.

N.B.—*The above Scale of Charges is not applicable to Analyses made for Persons commercially engaged in the Manufacture or Sale of Manures.*

The Address of Professor Way, the Consulting Chemist of the Society, is 15, Welbeck Street, Cavendish Square, London, (W), to which all letters and parcels should be directed.

By Order of the Council,

JAMES HUDSON, Secretary.

Royal Agricultural Society of England.

1857—1858.

President.

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Walsingham, Lord
Webb, Jonas
Western, Thomas Burch
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Secretary.

JAMES HUDSON, 12, *Hanover Square*, *London*.

Consulting-Chemist—Dr. Augustus Voelcker, Royal Agricultural College, Cirencester.
Veterinary-Inspector—JAMES BEART SIMONDS, Royal Veterinary College, N.W.
Consulting Engineer—JAMES EASTON, or C. E. AMOS, The Grove, Southwark, S.E.
Seedsmen—THOMAS GIBBS and Co., Corner of Halfmoon Street, Piccadilly, W.
Publisher—JOHN MURRAY, 50, Albemarle Street, W.
Bankers—A. M., C., A. R., H., R., and E. A. DRUMMOND, Charing Cross, S.W.

MEMORANDA.

Address of Letters.—The Society's office being situated in the new postal district designated by the letter **W**, members. in their correspondence with the Secretary, are requested to subjoin that letter to the usual address.

General Meeting in London, on Saturday, May 22, 1858, at Twelve o'clock.

Country Meeting at Chester, in the week commencing Monday, July 19, 1858.

General Meeting in London, in December, 1858.

Monthly Council (for transaction of business), at 12 o'clock on the first Wednesday in every month, excepting January, September, and October: open only to Members of Council and Governors of the Society.

Weekly Council (for practical communications), at 12 o'clock on all Wednesdays in February, March, April, May, June, and July, excepting the first Wednesday in each of those months, and during adjournment: open to all Members of the Society, who are particularly invited by the Council to avail themselves of this privilege.

Adjournments.—The Council adjourn over Easter week, and occasionally over Passion and Whitsun weeks; from the first Wednesday in August to that in November; and from the first Wednesday in December to the first Wednesday in February.

Diseases of Cattle, Sheep, and Pigs.—Members have the privilege of applying to the Veterinary Committee of the Society; and of sending animals to the Royal Veterinary College, on the same terms as if they were subscribers to the College.—(Statement of Members' Veterinary Privileges given in Journal, vol. XI., Appendix, pp. viii, ix; vol. XII., Appendix, p. iv; vol. XIII., Appendix, p. xxxiv; vol. XIV., Appendix, p. v; and may be had separately on application to the Secretary.)

Local Cheques: requested not to be forwarded for payment in London; but London Cheques, or Post-office Orders (payable to "James Hudson"), to be sent in lieu of them. Members may conveniently transmit their Subscriptions to the Society, by requesting their Country Bankers to pay (through their London Agents) the amount at the Society's Office (No. 12, Hanover Square, London), between the hours of ten and four, when official receipts, signed by the Secretary, will be given for such payments.

New Members.—Every candidate for admission into the Society must be proposed by a Member; the proposer to specify in writing the full name, usual place of residence, and post-town, of the candidate, either at a Council meeting, or by letter addressed to the Secretary.

Packets by Post.—Packets not exceeding two feet in length, width, or depth, consisting of written or printed matter (but not containing letters sealed or open), if sent without envelopes, or enclosed in envelopes open at each end, may be forwarded by the inland post, if stamped, at the following rates:—

For a packet not exceeding	4 ounces	(or quarter of a pound) . . .	1 penny.
,, ,, ,,	8 ,,	(or half a pound)	2 pence.
,, ,, ,,	16 ,,	(or one pound)	4 ,,
,, ,, ,,	24 ,,	(or one pound and a half) . .	6 ,,
,, ,, ,,	32 ,,	(or two pounds)	8 ,,

[And so on in the proportion of 8 ounces for each additional 2*d*.]

*** Members may obtain on application to the Secretary copies of an Abstract of the Charter and Bye-Laws, of a Statement of the General Objects, &c., of the Society, and of other printed papers connected with special departments of the Society's business.

Royal Agricultural Society of England.

GENERAL MEETING,

12, Hanover Square, Friday, December 11, 1857.

REPORT OF THE COUNCIL.

The Society has gained since the last half-yearly meeting 150 new members on its list, and consists, at the present time, of—

83	Life Governors,
135	Annual Governors,
908	Life Members,
4074	Annual Members, and
18	Honorary Members,
5218	

The Council have unanimously elected Viscount Eversley one of the Vice-Presidents of the Society, in the place of the late Earl Fitzwilliam.

The funded capital of the Society stands at 9264*l.* 8*s.* 11*d.* in the New Three-per-cents. Stock.

Professor Way, the Consulting-Chemist of the Society, having tendered his resignation of that office, which the Council have accepted, a special Committee has been appointed to report to the Council, in February next, their recommendation of the arrangements to be adopted for the discharge of the duties of that appointment.

Professor Simonds, the Veterinary-Inspector of the Society, has made his report to the Council of his observations and investigations abroad, on the occurrence and nature of the Cattle-plague in Prussia, Austria, and the confines of Poland; and a counterpart of that report has been transmitted to the Highland and Agricul-

tural Society of Scotland, and to the Royal Agricultural Improvement Society of Ireland. Professor Simonds has also made several verbal reports to the Council on his investigations into the nature of diseases which have broken out in several parts of the country among the cattle and sheep of members of the Society.

The Salisbury Meeting has been one of the most remarkable assemblages of live-stock and implements ever held in this country. Almost uniform excellence distinguished the several classes of animals exhibited, while the implements were marked by a high degree of simplicity combined with efficiency. The Show itself was one of the largest ever held by the Society, and was attended by a greater number of visitors than on any former occasion. The success of that meeting affords to the Council a well-grounded assurance of the practical value of the Society's operations in carrying out the great national objects for which it was founded; and encourages them in their continued endeavours to render the future country meetings still more effective, without infringing to an injurious extent upon the financial resources of the Society. In order to combine these objects the Council have under consideration the adoption of several plans which appear likely to lead to improved arrangements in the Country Meeting department. The Mayor and Corporation of Salisbury and the Local Committee co-operated most cordially with the Council in carrying out the details of the Meeting and bringing it to so successful an issue; and the Members were indebted to the Right Hon. Sidney Herbert, for the reception he gave them at Wilton; to Mr. Rawlence and Mr. Squarey, for the inspection of their water-meadows; and to the latter gentleman, for the interesting lecture he delivered on the occasion, in explanation of their construction and peculiar value; as well as to Mr. Stephen Mills for his invitation to inspect the light-land system of Wiltshire farming, as carried out on his own extensive farms in that county.

The Country Meeting to be held next year at Chester will be distinguished by the unusual amount of Local Prizes placed at the disposal of the Society by the Local Committee of that city, by the triennial exhibition and trial of steam-engines and agricul-

tural steam machinery generally, and by the peculiar advantages of its position in reference to railway communication.

The local prizes may be represented by the following classification :—

Cheshire Cheese and Cheese Makers	£441
Dairy Cattle	170
Horses	215
Welsh Cattle	195
Established Breeds (not including Short-horns, Herefords, or Devons)	30
Sheep (Welsh, Shropshire-Downs, and Cheviots)	230
	£1281

The prizes of the Society for the Chester Meeting are included in the following schedules :—

1. Live Stock.

Short-horned Cattle	£170
Herefords	170
Devons	170
Cattle of other Breeds	45
Agricultural Horses	130
Dray Horses	75
Other Horses	105
Leicester Sheep	90
Southdown Sheep	90
Long-woolled Sheep	90
Short-woolled Sheep	90
Pigs	80
Poultry	119
	£1,424

2. Implements and Machinery.

Portable Steam Engines	£60
Fixed Steam Engines	30
Boiler for a Fixed Steam Engine	10
Portable Thrashing Machines	55
Fixed Thrashing Machines	30
Corn Dressing Machines	10
Screen for Corn	3
Screen for Seed	3
Chaff Cutters	13
Grinding Mills	15
Linseed or Corn Crusher	5
Oilcake Breakers	8
Bone Mill	10
Bone-dust Mill	5
Turnip Cutters	6
Root Pulper	3
Carried forward	£266

Brought forward	..£ 266
Churn	3
Cheese-making Apparatus	3
Cheese Press	3
Steam-Cultivator	500
	£775

Miscellaneous awards .. .. 21 Silver Medals.

The Prize Sheets, containing the special terms on which these various prizes are offered, the conditions under which the competition for them will take place, and the general regulations for exhibition and trial, are now in the press, and will shortly be ready for distribution. The Implement Prize Sheet will include the recommendations of the Implement Committee, in reference to the suggestions obtained by a circular issued, by order of the Council, to each exhibitor in that department, and to each of the Implement Judges, during the last three years.

By order of the Council,

James Hudson, Secretary.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

Half-Yearly Account from the 1st of January to the 30th of June, 1857.

Receipts during the half-year.

	£.	s.	d.
Balance in the hands of the Bankers, Jan. 1, 1857	438	12	8
Petty Cash Balance in the hands of the Secretary, Jan. 1, 1857	17	1	8
Dividends on Stock	129	14	1
Governors' Life-Compositions	90	0	0
Governors' Annual Subscriptions	569	0	0
Members' Life-Compositions	403	0	0
Members' Annual Subscriptions	1836	5	0
Journal Receipts	161	13	0
Sale of old Catalogues	2	3	0
Country Meeting Receipts:—			
Salisbury	1500	0	0
	£5147	9	5

(Signed) THOMAS RAYMOND BARKER, *Chairman*, C. B. CHALLONER, HENRY WILSON, } *Finance Committee.*

Payments during the half-year.

	£.	s.	d.
Permanent Charges	165	0	0
Taxes and Rates	19	9	0
Establishment Charges *	1221	6	9
Postage and Carriage	26	3	11
Advertisements	14	5	0
Journal Payments	1098	11	7
Essay Prizes	150	0	0
Veterinary Grant	200	0	0
Chemical Grant	150	0	0
Chemical Investigations	100	0	0
Country Meeting Payments:—			
Chelmsford	464	0	10
Salisbury	525	6	0
Subscriptions, over-paid by Bankers, returned	4	0	0
Sundry items of Petty Cash	3	10	11
Balance in the hands of the Bankers, June 30, 1857	989	8	10
Petty Cash Balance in the hands of the Secretary, June 30, 1857	16	6	7
	£5147	9	5

Examined, audited, and found correct this 4th day of December, 1857.

(Signed) GEORGE I. RAYMOND BARKER, WILLIAM ASTBURY, } *Auditors on the part of the Society.*

* Under this head is included the sum of 703*l.* 4*s.* 11*d.* paid on account of repairs required in the house of the Society.

COUNTRY-MEETING ACCOUNT: SALISBURY, 1857.

RECEIPTS.

	£.	s.	d.
Subscription from Salisbury	1500	0	0
Prizes offered by the Local Committee at Salisbury for Hampshire-Down Sheep	120	0	0
Prize offered by M. Dutrône for Polled Bull	5	0	0
Non-Members' Fees for the entry of Live Stock	146	7	6
Non-Members' Fees for the entry of Implements	26	0	0
Implement-Makers' payment for shedding required	614	2	9
Admissions to Show and Trial Yards	3147	15	9
Sale of Catalogues of Implements and Stock	324	17	0
Fines for the non-Exhibition of Live-Stock	2	0	0
Sale of Dinner Tickets	78	0	0
Sale of Council Badges	3	0	0
Excess of Payments over Receipts, on account of the Salisbury Meeting, chargeable on the General Funds of the Society	315	12	11
	£6612	15	11

PAYMENTS.

	£.	s.	d.
Show and Trial Yard Works, Poultry-Coops, Hurdles, Entrance-Turnstiles	2530	9	1
Trial Land for Steam-Cultivators, Compensations, Water-supply, Cooperage	231	7	6
Yardmen, Fieldmen, Clerks, Money-takers, Door-keepers, Catalogue-sellers	217	2	3
Judges of the Show	344	0	0
Judges' Refreshments	56	19	0
Veterinary-Inspector and Assistant	26	0	0
Consulting-Engineers	89	9	9
Hire of Farm Horses	56	10	0
Metropolitan Police	86	4	0
Green Food	139	18	0
Hay and Straw	146	19	6
Poultry Food	7	18	9
Coals, Seeds, Manure, and Cream, for Trials	17	18	6
Ropes, Bags, Padlocks, and Brooms	6	5	0
Stationery	20	2	11
Advertisements	128	9	3
Postage, Carriage, and Messengers	24	10	5
Programmes of the Meeting	6	2	0
Prize-sheets, Certificates, Labels, Admission-Orders, Circulars, Railway-Papers	149	5	3
Live-stock and Implement Catalogues	349	2	0
Live-stock and Implement Award-sheets	29	13	0
Prizes of the Society, awarded and paid	1594	12	0
Prizes of the Local Committee, awarded and paid	120	0	0
Prize of M. Dutrône, awarded and paid	5	0	0
Dinner Contract	200	0	0
Dinner Tickets and Toast-Papers	2	5	0
Badges for Council, Stewards, and Judges	7	18	9
Official Staff: Travelling Expenses, Board, and Lodging	17	14	2
Loss on Sale of Foreign and other Coin	0	19	10
	£6612	15	11

Chester Meeting, 1858:

IN THE WEEK COMMENCING MONDAY, JULY 19.

SCHEDULES OF PRIZES.

I.—Live-Stock Prizes offered by the Society.

CATTLE.

SHORT-HORNED CATTLE.

To the owner of the best Bull, calved on or before the 1st of July, 1856, and not exceeding six years old	Thirty Sovereigns.
To the owner of the second-best ditto	Fifteen Sovereigns.
To the owner of the best Bull, calved since the 1st of July, 1856, and more than one year old	Twenty-five Sovs.
To the owner of the second-best ditto	Fifteen Sovereigns.
To the owner of the best Bull-Calf, above six and under twelve months old	Ten Sovereigns.
To the owner of the second-best ditto	Five Sovereigns.
To the owner of the best Cow in milk or in calf	Twenty Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.
To the owner of the best Heifer in milk or in calf, not exceeding three years old	Fifteen Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.
To the owner of the best Yearling Heifer ..	Ten Sovereigns.
To the owner of the second-best ditto	Five Sovereigns.

HEREFORD CATTLE.

To the owner of the best Bull, calved on or before the 1st of July, 1856, and not exceeding six years old	Thirty Sovereigns.
To the owner of the second-best ditto	Fifteen Sovereigns.
To the owner of the best Bull calved since the 1st of July, 1856, and more than one year old	Twenty-five Sovs.
To the owner of the second-best ditto	Fifteen Sovereigns.
To the owner of the best Bull-Calf, above six and under twelve months old	Ten Sovereigns.
To the owner of the second-best ditto	Five Sovereigns.
To the owner of the best Cow in milk or in calf	Twenty Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.
To the owner of the best Heifer in milk or in calf, not exceeding three years old	Fifteen Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.
To the owner of the best Yearling Heifer ..	Ten Sovereigns.
To the owner of the second-best ditto	Five Sovereigns.

DEVON CATTLE.

To the owner of the best Bull, calved on or before the 1st of July, 1856, and not exceeding six years old	Thirty Sovereigns.
To the owner of the second-best ditto	Fifteen Sovereigns.
To the owner of the best Bull, calved since the 1st of July, 1856, and more than one year old	Twenty-five Sovs.
To the owner of the second-best ditto	Fifteen Sovereigns.
To the owner of the best Bull-Calf, above six and under twelve months old	Ten Sovereigns.
To the owner of the second-best ditto	Five Sovereigns.
To the owner of the best Cow in milk, or in calf	Twenty Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.
To the owner of the best Heifer in milk or in calf, not exceeding three years old	Fifteen Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.
To the owner of the best Yearling Heifer ..	Ten Sovereigns.
To the owner of the second-best ditto	Five Sovereigns.

OTHER ESTABLISHED BREEDS.

(*Not including the Short-Horn, Hereford, or Devon Breed.*)

To the owner of the best Bull, calved on or before the 1st of July, 1856, and not exceeding six years old	Ten Sovereigns.
To the owner of the best Bull, calved since the 1st of July, 1856, and more than one year old	Ten Sovereigns.
To the owner of the best Cow, in milk or in calf	Ten Sovereigns.
To the owner of the best Heifer, in milk or in calf, not exceeding three years old	Ten Sovereigns.
To the owner of the best Yearling Heifer ..	Five Sovereigns.

HORSES.

AGRICULTURAL HORSES GENERALLY.

To the owner of the best Stallion for Agricultural Purposes, foaled on or before the 1st of January, 1856	Thirty Sovereigns.
To the owner of the second-best ditto	Fifteen Sovereigns.
To the owner of the best Stallion for Agricultural Purposes, foaled in the year 1856 ..	Twenty Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.
To the owner of the best Mare and Foal for Agricultural Purposes	Twenty Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.
To the owner of the best two-years old Filly for Agricultural Purposes	Fifteen Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.

DRAY HORSES.

To the owner of the best Stallion, foaled on or before the 1st of January, 1856	Thirty Sovereigns.
To the owner of the best Stallion, foaled in the year 1856	Fifteen Sovereigns.
To the owner of the best Mare, with her foal at her feet	Twenty Sovereigns.
To the owner of the best Filly, foaled in the year 1856	Ten Sovereigns.

OTHER HORSES.

To the owner of the best thorough-bred Stallion for getting hunters	Thirty Sovereigns.
To the owner of the second-best ditto	Twenty Sovereigns.
To the owner of the best Stallion for getting hackneys	Twenty Sovereigns.
To the owner of the best Brood Mare for breeding hunters	Twenty Sovereigns.
To the owner of the best Brood Mare for breeding hackneys	Fifteen Sovereigns.

SHEEP.

LEICESTERS.

To the owner of the best Shearling Ram	Twenty Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.
To the owner of the best Ram of any other age	Twenty Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.
To the owner of the best pen of five Shearling Ewes of the same flock	Twenty Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.

SOUTH-DOWNS.

To the owner of the best Shearling Ram	Twenty Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.
To the owner of the best Ram of any other age	Twenty Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.
To the owner of the best pen of five Shearling Ewes of the same flock	Twenty Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.

LONG-WOOLLED SHEEP:

(*Not qualified to compete as Leicesters.*)

To the owner of the best Shearling Ram ..	Twenty Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.
To the owner of the best Ram of any other age	Twenty Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.
To the owner of the best pen of five Shearling Ewes of the same flock	Twenty Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.

SHORT-WOOLLED SHEEP:

(*Not qualified to compete as Southdowns.*)

To the owner of the best Shearling Ram ..	Twenty Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.
To the owner of the best Ram of any other age	Twenty Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.
To the owner of the best pen of five Shearling Ewes of the same flock	Twenty Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.

PIGS.

To the owner of the best Boar of a large breed	Ten Sovereigns.
To the owner of the second-best ditto	Five Sovereigns.
To the owner of the best Boar of a small breed	Ten Sovereigns.
To the owner of the second-best ditto	Five Sovereigns.
To the owner of the best Breeding Sow of a large breed	Ten Sovereigns.
To the owner of the second-best ditto	Five Sovereigns.
To the owner of the best Breeding Sow of a small breed	Ten Sovereigns.
To the owner of the second-best ditto	Five Sovereigns.
To the owner of the best pen of three Breeding Sow-Pigs of a large breed, of the same litter, above four and under eight months old ..	Ten Sovereigns.
To the owner of the best pen of three Breeding Sow-Pigs of a small breed, of the same litter, above four and under eight months old ..	Ten Sovereigns.

FARM POULTRY.

DORKING FOWLS (Chickens of 1858).

To the owner of the best Cock and two Pullets	Five Sovereigns.
To the owner of the second-best ditto	Three Sovereigns.
To the owner of the third-best ditto	Two Sovereigns.
To the owner of the fourth-best ditto	One Sovereign.

DORKING FOWLS (More than one year old).

To the owner of the best Cock and two Hens	Five Sovereigns.
To the owner of the second-best ditto	Three Sovereigns.
To the owner of the third-best ditto	Two Sovereigns.
To the owner of the fourth-best ditto	One Sovereign.

SPANISH FOWLS.

To the owner of the best Cock and two Hens	Five Sovereigns.
To the owner of the second-best ditto	Three Sovereigns.
To the owner of the third-best ditto	Two Sovereigns.
To the owner of the fourth-best ditto	One Sovereign.

GAME FOWLS.

To the owner of the best Cock and two Hens	Five Sovereigns.
To the owner of the second-best ditto	Three Sovereigns.
To the owner of the third-best ditto	Two Sovereigns.
To the owner of the fourth-best ditto	One Sovereign.

COCHIN-CHINA FOWLS.

To the owner of the best Cock and two Hens	Five Sovereigns.
To the owner of the second-best ditto	Three Sovereigns.
To the owner of the third-best ditto	One Sovereign.

BRAHMA-POOTRA FOWLS.

To the owner of the best Cock and two Hens	Three Sovereigns.
To the owner of the second-best ditto	Two Sovereigns.
To the owner of the third-best ditto	One Sovereign.

HAMBURGH FOWLS (Silver-Pencilled).

To the owner of the best Cock and two Hens	Three Sovereigns.
To the owner of the second-best ditto	Two Sovereigns.
To the owner of the third-best ditto	One Sovereign.

HAMBURGH FOWLS (Golden-Pencilled).

To the owner of the best Cock and two Hens	Three Sovereigns.
To the owner of the second-best ditto	Two Sovereigns.
To the owner of the third-best ditto	One Sovereign.

HAMBURGH FOWLS (Silver-Spangled).

To the owner of the best Cock and two Hens	Three Sovereigns.
To the owner of the second-best ditto	Two Sovereigns.
To the owner of the third-best ditto	One Sovereign.

HAMBURGH FOWLS (Golden-Spangled).

To the owner of the best Cock and two Hens	Three Sovereigns.
To the owner of the second-best ditto	Two Sovereigns.
To the owner of the third-best ditto	One Sovereign.

POLAND FOWLS.

To the owner of the best Cock and two Hens	Four Sovereigns.
To the owner of the second-best ditto	Three Sovereigns.
To the owner of the third-best ditto	Two Sovereigns.
To the owner of the fourth-best ditto	One Sovereign.

GEESE.

To the owner of the best Gander and two Geese	Four Sovereigns.
To the owner of the second-best ditto	Two Sovereigns.
To the owner of the third-best ditto	One Sovereign.

AYLESBURY DUCKS.

To the owner of the best Drake and two Ducks	Three Sovereigns.
To the owner of the second-best ditto	Two Sovereigns.
To the owner of the third-best ditto	One Sovereign.

ROUEN DUCKS.

To the owner of the best Drake and two Ducks	Three Sovereigns.
To the owner of the second-best ditto	Two Sovereigns.
To the owner of the third-best ditto	One Sovereign.

EAST-INDIAN DUCKS.

To the owner of the best Drake and two Ducks	Three Sovereigns.
To the owner of the second-best ditto	Two Sovereigns.
To the owner of the third-best ditto	One Sovereign.

TURKEYS.

To the owner of the best Turkey Cock and two Hens	Three Sovereigns.
To the owner of the second-best ditto	Two Sovereigns.
To the owner of the third-best ditto	One Sovereign.

II.—Implement and Machinery Prizes offered by the Society.

Steam-Cultivator	Five Hundred Sovs.
Portable Steam-Engine, above 8 and not exceeding 12 horse-power	Twenty-five Sovs.
Portable Steam-Engine, not exceeding 8 horse-power	Twenty-five Sovs.
Second-best ditto	Ten Sovereigns.
Fixed Engine, not exceeding 10 horse-power ..	Twenty Sovereigns.
Second-best ditto	Ten Sovereigns.
Boiler for a Fixed Engine, not exceeding 10 horse-power	Ten Sovereigns.
Portable Thrashing Machine, not exceeding 6 horse-power	Ten Sovereigns.
Portable Thrashing Machine, not exceeding 8 horse-power, for large occupations	Fifteen Sovereigns.
Portable Thrashing Machine, not exceeding 8 horse-power, that will best prepare the corn for the Finishing Dressing-Machine	Fifteen Sovereigns.
Portable Combined Thrashing-Machine, that will best prepare the corn for market, not exceeding 8 horse-power	Fifteen Sovereigns.
Fixed Combined Steam Thrashing-Machine, for preparing corn for market, not exceeding 10 horse-power	Twenty Sovereigns.
Fixed Combined Steam Thrashing-Machine, for preparing corn for market, not exceeding 8 horse-power	Ten Sovereigns.
Corn-Dressing Machine	Five Sovereigns.
Corn-Dressing Machine, for preparing corn for market after being riddled and screened ..	Five Sovereigns.
Screen for Corn	Three Sovereigns.
Ditto for Seed	Three Sovereigns.
Chaff-Cutter for horse or steam power	Five Sovereigns.
Second-best ditto	Three Sovereigns.
Chaff-Cutter for hand-power	Three Sovereigns.
Second-best ditto	Two Sovereigns.
Grinding Mill with steel or stone grinders, for grinding agricultural produce into meal, to be worked by horse or steam power	Ten Sovereigns.
Grinding Mill with steel grinders, for grinding agricultural produce	Five Sovereigns.
Linseed or Corn Crusher	Five Sovereigns.
Oil-Cake Breaker	Five Sovereigns.
Ditto for Common Cake	Three Sovereigns
Bone Mill, to be worked by steam or other power	Ten Sovereigns.
Bone-Dust Mill	Five Sovereigns.

Turnip-Cutter	Three Sovereigns.
Ditto for hand-power	Three Sovereigns.
Root-Pulper	Three Sovereigns.
Churn	Three Sovereigns.
Cheese-making Apparatus	Three Sovereigns.
Cheese-Press	Three Sovereigns.
Miscellaneous Awards for Essential Improvements in any of the Implements or Machinery exhibited	Silver Medals. Twenty-one.
Any new Implement, such sum as the Council, on the Report of the Judges, may think proper to award.	

SPECIAL CONDITIONS.

(1). The Portable Steam-engine.

1. One of the portable steam-engines must not be more than eight horses nominal power, nor must the diameter of the cylinder be more than $9\frac{3}{4}$ inches. The one above eight must not exceed twelve horses nominal power, must have two cylinders, and the diameter of each cylinder must not exceed 8 inches.

2. The tubes in the boiler must not be less than $2\frac{1}{2}$ inches diameter, not less than No. 12 on the metal-gauge in thickness, nor placed a less distance apart than 1 inch from each other. The tube-plates must be made of either "Lowmoor" or "Bowling" iron, and the "trade mark" of the iron company must be legible on each plate.

3. The exhibitor will be required to furnish to the Society, along with the specification, a longitudinal and transverse sectional plan of the boiler, showing the action of the fire upon the flues, and also to state in writing:—

(*a*) The thickness and quality of the boiler plates.
(*b*) The diameter of the cylinder.
(*c*) The length of the stroke of the piston.
(*d*) The number of revolutions, and diameter of the crank and shaft, which must be made of wrought iron.
(*e*) The diameter and weight of the fly-wheel.
(*f*) The diameter of the driving pulley (which must not be less than 6 inches wide, nor move at a less velocity than 1600 feet per minute). A second pulley must also be fitted, and which must not be less than 5 inches wide, nor move at a less velocity than 900 feet per minute, for driving chaff-cutting or other machines requiring a slower motion than can be given by the large driving-pulley.
(*g*) The number of horse-power the engine is calculated to work at.

4. The engine must be provided with a good water-gauge, and with a short piece of pipe fitted with a cock, having a thread to fit the $\frac{1}{2}$-inch gas pipe, for the purpose of fixing a pressure gauge.

5. If the engine be worked on the expansive principle, it is desirable that the means used for cutting off the steam be of a simple character. No force-pump must be fitted with more than two valves, and these must be easy of access. If a heater for water be used, it must be so constructed that the engine will work either with or without it.

6. The Society will be empowered to select any of the engines exhibited, for the purpose of driving other machinery under trial, and will pay the exhibitor

1l. per day for the use of the engine and a competent attendant during the time the services of such engine may be required.

7. In adjudicating on the merits of the engine, reference will be had to the simplicity of construction and the probable durability of the engine, considered as a whole and in detail, also the portability of the engine, without losing sight of the strength required for safety, the economy of working, and the price.

8. The Judges will be instructed to have the boilers filled properly with water, the steam got up to the working pressure of 45 lbs. on the square inch, the engine set to work for a short time, and then cooled down.

9. The exhibitor will then be required to take the engine to pieces in the presence of the Judges, and withdraw the piston, slide expansion valve, and pump valves, for examination. Two men will only be allowed to assist in the operation, and the time of taking to pieces and replacing the parts will be noted. When the whole is put together the engine will undergo the trial of working in the ordinary manner, and in accordance with the practice of former meetings. If after trial the Judges should require any one or more of the tubes withdrawn for examination, the exhibitor shall withdraw such tube or tubes.

(2). Fixed Steam-engines.

1. The fixed steam-engine must not be more than ten horses nominal power, and the diameter of the cylinder must not exceed $11\frac{1}{2}$ inches.

2. The exhibitor will not be required to bring a boiler, as steam will be furnished by boilers supplied by the Society, but he will be required to fix the engine, also to find the materials for doing so, at his own expense, and in such a position in the Trial Yard as may be pointed out to him.

3. He must also furnish the Society with plans and specifications, fully describing the boiler and fittings that he would supply to his customer with the engine he exhibits, such boiler to possess the capacity of 25 superficial feet of effective heating surface, and $\frac{3}{4}$ of one foot of effective fire-grate for each horse-power of the nominal power of the engine. No tubes will be allowed of less diameter than $2\frac{1}{2}$ inches, nor thinner than No. 12 on the metal gauge. Also the leading particulars of the engine he intends to exhibit; such as—

(*a*) The horse-power of the engine.
(*b*) The diameter of the cylinder.
(*c*) The length of stroke.
(*d*) The number of strokes per minute.
(*e*) The diameter of crank-shaft.
(*f*) The diameter and weight of fly-wheel.
(*g*) The diameter of driving pulley (which should not be less than 7 inches wide, nor travel less than 1200 feet per minute).

The greatest attention will be paid by the Mechanical Judges to the drawings and specifications relating to the boilers of the Prize Fixed Engines. Such drawings and specifications will remain the copyright property of the Society; and will be published in the Journal of the Society for the purpose of guiding its members in making their purchases.

4. The engine exhibited must be supplied with a governor, and have a starting-cock to regulate the supply of steam, and be fitted with a thread equal to the 2-inch gas pipe.

5. If the engine is worked on the expansive principle, a simple means must be used for cutting off the steam. No force-pump must be fitted with more than two valves, and these must be easy of access. If a heater for water be used it must be so constructed that the engine will work either with or without it.

6. In adjudicating on the merits of the fixed engines, reference will be had to the price, simplicity of construction, probable durability of the whole and in

detail, and the means provided for easy access to the working parts, and to economy of fuel.

(3). Fixed Steam-boilers.—"Special Prize."

The boiler must possess an effective heating surface of 25 superficial feet and three-fourths of one foot superficial of effective fire-grate surface for each nominal horse-power. Clear and concise drawings and specifications, with the cost of forming the boiler-setting, with its flues and passages up to the entrance into a chimney, must be furnished to the Society, for publication, should the Council think fit to publish them.

If tubes are used, none less than 3 inches diameter and 1 inch apart will be allowed; and no tube-plates shall be used which are not made either of "Low Moor" or "Bowling" iron, and bearing the ironmaster's trading mark. The fittings which the exhibitor supplies must be shown with the boiler, and a guarantee given that he will supply the public with boilers and fittings of a similar description, at the price named, for twelve months certain after the prize has been awarded to the exhibitor.

(4). Chaff-cutters and Mills.

Chaff-cutters will be required to cut chaff three-eighths of one inch in length, in the trial. The exhibitor may provide means for cutting various lengths, to show the usefulness of his production. The Judges will be instructed to use thin slips of wood for determining the length of chaff cut; and if the deviation from the given length of three-eighths of an inch is, in their judgment, too much departed from, they may refrain from taking any notice of the machine in question; and in estimating the *weight* of chaff cut, allowance must be made and taken according to the length of chaff cut.

Grinding mills will be fairly set to work, and their production compared with a sample which the Judges shall cause to be produced by one mill, and which produce shall, in their estimation, be adapted for the farmers' purposes of feeding. The mill under trial shall be "set" until it produces like meal; and the *time*, *power*, and *quantity of work* noted.

Steel mills for grinding will not be expected to produce softened meal, although any mill or combination, with rollers or otherwise, which will do so, will receive consideration from the Judges; but mills of this class generally will be tried and compared in the class as grinding mills with stones are compared in their class.

(5). Speed and Pressure.

All implements turned by the winch or hand-crank shall not be worked, at any trial, beyond the following speed—namely, 42 revolutions per minute for 12-inch crank, 37 revolutions for 14-inch crank, 32 revolutions for 16-inch crank; and, in addition to the winch-handle which must be supplied with the machine, for the purpose of trial, a pulley not less than 4 inches wide, of the same radius as the winch, must be fitted to each machine. The machine, in its trial, will be driven by the pulley of the testing machine, which pulley is 31 inches diameter, and will make $32\frac{1}{2}$ revolutions per minute.

Chaff-cutting and other small machines, worked usually by horses and by steam power, will be worked, when under trial, by pulleys not less than $5\frac{1}{2}$ inches wide, moving with a velocity of, or about, 900 feet per minute.

Exhibitors are requested to pay particular attention to the instructions given for the speed and working of their machines, as the Judges may refuse to try any machine not fitted in accordance with the instructions.

The working pressure of steam to be 45 lbs. per square inch, which must not be exceeded.

III.—Special Prizes offered by the Chester Local Committee.

CHEESE.

(Of the Class usually denominated Cheshire Cheese.)

CHAMPION PRIZE.

No.		
1.—	For the four best Cheeses, coloured or uncoloured, not less than 60 lbs. weight each, and made in the year 1857, and entered for competition in Classes No. 1 or 2, a prize of	One Hundred Sovereigns.

The winner of the Champion Prize will not be entitled to receive any other Prize for Cheese.

COLOURED CHEESES MADE IN 1857.

2.—	For the four best Cheeses not less than 60 lbs. weight each	Thirty Sovereigns.
3.—	Ditto ditto, second best	Twenty Sovereigns.
4.—	For the four best Cheeses not less than 40 lbs., and under 60 lbs. each	Twenty Sovereigns.
5.—	Ditto ditto, second best	Fifteen Sovereigns.
6.—	For the four best Cheeses under 40 lbs. weight each	Fifteen Sovereigns.
7.—	Ditto ditto, second best	Ten Sovereigns.

UNCOLOURED CHEESES MADE IN 1857.

8.—	For the four best Cheeses, not less than 50 lbs. weight each	Thirty Sovereigns.
9.—	Ditto ditto, second best	Twenty Sovereigns.
10.—	For the four best Cheeses, under 50 lbs. weight each	Twenty Sovereigns.
11.—	Ditto ditto, second best	Fifteen Sovereigns.

Any person may compete for both Coloured and Uncoloured Cheeses, but no person shall be allowed to receive more than one Prize in each Class.

COLOURED OR UNCOLOURED CHEESES MADE IN THE YEAR 1858.

12.—	For the four best Cheeses, not less than 60 lbs. weight each	Twenty Sovereigns.
13.—	Ditto ditto, second best	Fifteen Sovereigns.

No.	
14.—For the four best Cheeses, not less than 40 lbs., and under 60 lbs. each	Fifteen Sovereigns.
15.—Ditto ditto, second best	Ten Sovereigns.
16.—For the four best Cheeses, under 40 lbs. weight each	Ten Sovereigns.
17.—Ditto ditto, second best	Five Sovereigns.

Rule 1.—Cheeses, of the class usually denominated Cheshire cheeses, made in any part of the North Wales district of the Royal Agricultural Society of England, which comprises the counties of Chester, Salop, Stafford, and the whole of North Wales, or in any of the counties adjoining to the county of Chester, will be qualified to compete for any of the prizes for cheeses, subject to the reservation as to the Champion Prize in Rule 5.

2.—In the event of any question arising as to whether any cheese exhibited does or does not come under the terms of Rule 1, the Stewards of the Yard, with the assistance of the Judges, to consider the question, and their decision to be final.

3.—The Exhibitor is in every case to be the manufacturer and bonâ fide owner of the cheeses and stock from which the cheeses are made.

4.—Any Exhibitor may compete for coloured and uncoloured cheeses, but no Exhibitor shall be allowed to compete for or receive more than one prize in each class.

5.—No entry is required for the Champion Prize; the cheeses to which the same will be awarded will be selected from those entered for prizes 1 and 4 in classes 1 and 2, and the winner of the Champion Prize will not be allowed to receive any additional prize for cheeses except in class 3.

6.—Any cheeses which may be found to have been bored or tried in any way before being exhibited on the show-ground will be disqualified.

7.—The Committee reserve the privilege of purchasing any of the prize cheeses for the use of the Royal Agricultural Society, or for the purpose of presentation, at a price to be fixed by the Judges.

DAIRY MAIDS AND CHEESE MAKERS.

To the Dairy Maid or person who shall have made the Dairy of Cheeses winning the Champion Prize	Ten Sovereigns.
To the Dairy Maid or person who shall have made the Dairy of Cheeses winning the first Prizes, Nos. 2 or 8, in Classes I. and II. ..	Five Sovereigns.
To the Dairy Maid or person who shall have made the Dairy of Cheeses winning Prizes Nos. 3, 4, 9, 10, and 12	Three Sovereigns.

To the Dairy Maid or person who shall have made the Dairy of Cheeses winning Prizes Nos. 5, 6, 11, 13, and 14	Two Sovereigns.
To the Dairy Maid or person who shall have made the Dairy of Cheeses winning Prizes Nos. 7, 15, 16, and 17	One Sovereign.

If the Prize Cheeses shall not have been made by the ordinary maker of the Dairy, the Prize to the Dairy Maid or maker to be withheld.

CATTLE.

BEST ADAPTED FOR DAIRY PURPOSES.

To the owner of the best Bull, calved on or before the 1st of July, 1856, and not exceeding four years old	Thirty Sovereigns.
To the second-best ditto	Fifteen Sovereigns.
To the owner of the best Bull, calved since the 1st of July, 1856, and more than one year old	Fifteen Sovereigns.
To the second-best ditto	Ten Sovereigns.
To the owner of the best pair of Cows, in milk or in calf	Thirty Sovereigns.
To the second-best ditto	Fifteen Sovereigns.
To the third-best ditto	Ten Sovereigns.
To the owner of the two best Heifers, in milk or in calf, not exceeding three years old ..	Fifteen Sovereigns.
To the second-best ditto	Ten Sovereigns.
To the third-best ditto	Five Sovereigns.
To the owner of the two best Yearling Heifers	Ten Sovereigns.
To the second-best ditto	Five Sovereigns.

HORSES.

AGRICULTURAL HORSES GENERALLY.

To the owner of the best Stallion for Agricultural Purposes, foaled on or before the 1st January, 1856	Thirty Sovereigns.
To the owner of the second-best ditto	Twenty Sovereigns.
To the owner of the best Stallion for Agricultural Purposes, foaled in the year 1856 ..	Twenty Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.

DRAY HORSES.

To the owner of the best Stallion, foaled on or before the 1st of January, 1856	Fifteen Sovereigns.
To the owner of the best Stallion, foaled in the year 1856	Ten Sovereigns.

OTHER HORSES.

To the owner of the best Thorough-bred Stallion for getting Hunters	Thirty Sovereigns.
To the owner of the second-best ditto	Twenty Sovereigns.
For the best Mountain Pony Stallion, not exceeding 13 hands high	Ten Sovereigns.
For the second-best ditto	Five Sovereigns.
For the best Mountain Mare Pony, not exceeding 13 hands, and foal	Ten Sovereigns.
For the second-best ditto	Five Sovereigns.
For the best Stallion for improving the breed of Welsh Ponies	Ten Sovereigns.
For the second-best ditto	Five Sovereigns.
For the best Mare Pony, not exceeding 14 hands, and foal	Ten Sovereigns.
For the second-best ditto	Five Sovereigns.

WELSH BREEDS.

For the best Bull, above two and under three years	Thirty Sovereigns.
For the second-best ditto	Fifteen Sovereigns.
For the best Bull, of any age	Thirty Sovereigns.
For the second-best ditto	Fifteen Sovereigns.
For the best Cow, in calf or in milk, above two years old	Twenty Sovereigns.
For the second-best ditto	Fifteen Sovereigns.
For the third-best ditto	Ten Sovereigns.
For the best Breeding Heifer, above one year old and under two	Fifteen Sovereigns.
For the second-best ditto	Ten Sovereigns.
For the third-best ditto	Five Sovereigns.
For the best Breeding Heifer, above two years old and under three years	Fifteen Sovereigns.
For the second-best ditto	Ten Sovereigns.
For the third-best ditto	Five Sovereigns.

ESTABLISHED BREEDS OTHER THAN SHORT-HORN, HEREFORD, OR DEVON.

(*To the Winner of the Society's Prize for "Other Established Breeds."*)

For the best Bull calved on or before the 1st July, 1856, and not exceeding four years old	Fifteen Sovereigns.
For the best Bull calved before the 1st July, 1856	Fifteen Sovereigns.

The Local Committee have made the above additions to the Society's Prizes to induce competition from the West Highlands and elsewhere.

SHEEP.

For the best Welsh Mountain Ram of any age	Fifteen Sovereigns.
For the second-best ditto	Ten Sovereigns.
For the best pen of Five Welsh Mountain Ewes, of any age	Fifteen Sovereigns.
For the second-best ditto	Ten Sovereigns.
For the third-best ditto	Five Sovereigns.
For the best Shearling Ram of the Shropshire Down breed	Twenty Sovereigns.
For the second-best ditto	Ten Sovereigns
For the best Ram of the Shropshire Down breed of any other age	Twenty Sovereigns.
For the second-best ditto	Ten Sovereigns.
For the best pen of Five Shearling Ewes of the same breed	Fifteen Sovereigns.
For the second-best ditto	Ten Sovereigns.
For the best Shearling Ram of the Cheviot breed	Twenty Sovereigns.
For the second-best ditto	Ten Sovereigns.
For the best Ram of the Cheviot breed	Twenty Sovereigns.
For the second-best ditto	Ten Sovereigns.
For the best pen of Shearling Ewes, of the Cheviot breed	Twenty Sovereigns.
For the second-best ditto	Ten Sovereigns.

SPECIAL CONDITIONS.

THE Special Prizes for Horses, Cattle, and Sheep, are open to competition from any part of the United Kingdom.

All Exhibitors will be subject to the general rules and regulations of the Royal Agricultural Society in every respect.

The stallions must have served or shall serve, for at least one season, in the county of Salop, Stafford, or Cheshire, or in North Wales. Should any prize be awarded to a stallion which has not served for one year at least in the county of Chester, Salop, or Stafford, or in North Wales, the payment of such prize will be deferred until the 1st of August, 1859, when, on its being shown to the satisfaction of the Local Committee that such stallion has served within the district during the season of 1859, the prize will be paid.

*** Forms of Certificate for entry, as well as Prize-Sheets for the Chester Meeting, containing the whole of the conditions and regulations, may be obtained at the Office of the Society, No. 12, Hanover Square, London.

DATES OF ENTRY.

ALL Certificates for the entry of Live Stock for the Chester Meeting must be forwarded to the Secretary of the Society, No. 12, Hanover Square, London (W.), by the 1st of May, and all other Certificates by the 1st of June. Certificates received after those respective dates will not be accepted, but returned to the persons by whom they have been sent.

The Prizes of the Royal Agricultural Society of England are open to general competition.